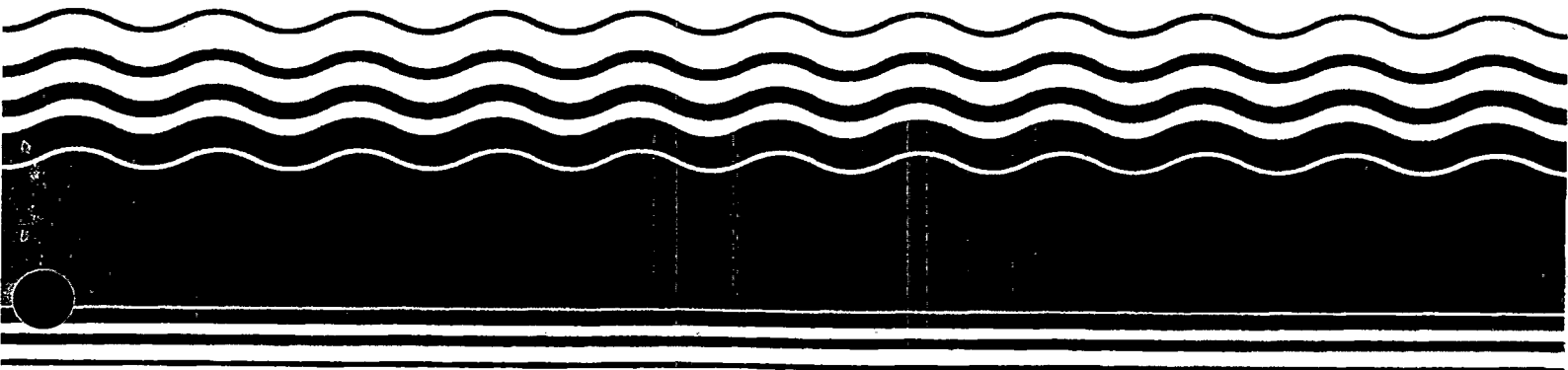


**PB99-963905  
EPA541-R99-009  
1999**

**EPA Superfund  
Record of Decision:**

**Boarhead Farm Site  
Bridgeton Township, PA  
11/18/1998**





# **SUPERFUND PROGRAM RECORD OF DECISION**



Boarhead Farms Superfund Site  
Bridgeton Township  
Bucks County, Pennsylvania

NOVEMBER 1998

## **DECLARATION**

### **SITE NAME AND LOCATION**

The Boarhead Farms Superfund Site  
Bridgeton Township, Bucks County, Pennsylvania

### **STATEMENT OF BASIS AND PURPOSE**

This decision document presents the final selected remedial action for the Boarhead Farms Superfund Site (Site). The remedial action was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA); and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record for the Site.

The Commonwealth of Pennsylvania has concurred with the selected remedy.

### **ASSESSMENT OF THE SITE**

Pursuant to duly delegated authority, I hereby determine pursuant to Section 106 of CERCLA, 42 U.S.C. § 9606, that actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to the public health, welfare, or environment.

### **DESCRIPTION OF SELECTED REMEDY**

The selected remedy described below is the only planned action for the Site. This remedy addresses contaminated soil hot spots, buried drums, contaminated groundwater, and offsite drinking water.

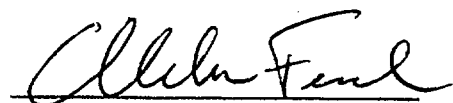
The selected remedy includes the following major components:

- 1) *Soil Aeration and Treatment of VOC Hot Spots:*** Mechanical aeration of soil hot spot areas to remove high levels of VOCs (primarily TCE and benzene) in a temporary onsite treatment building equipped with carbon filters.
- 2) *Excavation and Offsite Disposal of Buried Drums:*** Excavation and offsite disposal of buried drums to reduce the potential for continued migration of contaminants to the soil and groundwater as well as to reduce exposure risk.
- 3) *Groundwater Extraction, Metals Precipitation, and Air Stripping:*** Continued extraction and treatment of VOCs in groundwater via the existing interception trench and air stripping treatment system and addition of a metals precipitation unit to remove inorganics to reduce contaminants in the groundwater to below Maximum Contaminant Levels (MCLs).
- 4) *Installation of Additional Monitoring Wells:*** Installation of additional (specific number to be determined during remedial design) monitoring wells to monitor the effectiveness of the remedial action. These wells will be placed in areas along the perimeter of the Site to permit monitoring of migration, if any, of contaminated groundwater.
- 5) *Institutional Controls and Monitoring:*** Implementation of institutional controls to protect the integrity of the remedial action components and the previously installed cover soils to ensure continued protectiveness of the remedy.
- 6) *Residential Water Treatment:*** Continued maintenance of the granular activated carbon (GAC) filters that were installed on affected residential water wells in the surrounding area to prevent exposure to contaminated groundwater from the Site.
- 7) *Phytoremediation:*** Performance of treatability studies in the main former disposal areas of the Site to determine whether phytoremediation is a viable treatment technique to aid in the removal of VOC and metals contamination in the groundwater.

## STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment and is cost effective. EPA believes that the selected remedy will comply with all Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action. The selected remedy utilizes a permanent solution to the maximum extent practicable and satisfies the statutory preference for a remedy that employs treatment that reduces toxicity, mobility, or volume.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining onsite, a review by EPA will be conducted no less often than every five years after initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

  
Abraham Ferdas, Director  
Hazardous Site Cleanup Division  
EPA Region III

11/18/98  
Date



## **TABLE OF CONTENTS**

### **PART II - DECISION SUMMARY**

I.	SITE NAME, LOCATION, AND DESCRIPTION	1
II.	SITE HISTORY AND ENFORCEMENT ACTIVITIES	1
III.	HIGHLIGHTS OF COMMUNITY PARTICIPATION	3
IV.	SCOPE AND ROLE OF THE RESPONSE ACTION	4
V.	SUMMARY OF SITE CHARACTERISTICS	4
	A. Topography	4
	B. Climate	4
	C. Hydrology	4
	D. Land Use	5
VI.	NATURE AND EXTENT OF CONTAMINATION	6
	A. Surface Soil	6
	B. Subsurface Soil	7
	C. Surface Water	8
	D. Sediment	9
	E. Groundwater	9
	F. Hot Spots	11
	G. Buried Drums	11
	H. Air	11
VII.	SUMMARY OF SITE RISKS	12
	A. Human Health Risks	12
	1. Identification of Chemicals of Potential Concern	12
	2. Exposure Assessment	15
	3. Toxicity Assessment	16
	4. Human Health Effects	17
	5. Risk Characterization	17
	B. Ecological Risk Assessment	18
	C. Conclusions	19

VIII.	DESCRIPTION OF ALTERNATIVES	19
IX.	COMPARATIVE EVALUATION OF ALTERNATIVES	24
X.	SELECTED REMEDY AND PERFORMANCE STANDARDS	30
XI.	STATUTORY DETERMINATIONS	39
	A. Overall Protection of Human Health and the Environment	39
	B. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)	39
	C. Cost Effectiveness	40
	D. Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable	40
	E. Preference for Treatment as a Principal Element	40
XII.	DOCUMENTATION OF CHANGES FROM PROPOSED PLAN	41

APPENDIX A - TOXICOLOGICAL PROFILES OF SELECTED SITE CONTAMINANTS

APPENDIX B - FIGURES

APPENDIX C - TABLES

PART III - RESPONSIVENESS SUMMARY



## **FIGURES**

Figure 1 - Site Location

Figure 2 - Site Features and Areas of Investigation

Figure 3 - Site Location and Land Use

Figure 4 - Monitoring Well and Test Pit Locations

Figure 5 - Distribution of Inorganics and Organics in Soil

Figure 6 - Residential Well Locations

Figure 7 - Hot Spot Removal Areas

## **FIGURES**

**Figure 1 - Site Location**

**Figure 2 - Site Features and Areas of Investigation**

**Figure 3 - Site Location and Land Use**

**Figure 4 - Monitoring Well and Test Pit Locations**

**Figure 5 - Distribution of Inorganics and Organics in Soil**

**Figure 6 - Residential Well Locations**

**Figure 7 - Hot Spot Removal Areas**

## **TABLES**

Table 1	Areas of Investigation
Table 2	Monitoring Well Locations Where Federal MCLs or State HALs Were Exceeded in Groundwater
Table 3	Preliminary Remediation Goals for Groundwater
Table 4	Preliminary Remediation Goals for Soil
Table 5	Area Specific Exceedances of Preliminary Remediation Goals for COPCs in Subsurface Soil
Table 6	Residential Wells with MCL Exceedances (through 12/95)
Table 7	Summary of the COPCs Identified Through the Human Health RA
Table 8	Toxicity Values Used in the Human Health Assessment
Table 9	Human Health Risks at the Boarhead Farms Site
Table 10	Summary of Alternatives

### **PART III - RESPONSIVENESS SUMMARY**

#### **OVERVIEW**

#### **BACKGROUND**

- I. SUMMARY OF COMMENTS AND CONCERNS RAISED AT THE PUBLIC MEETING**
- II. SUMMARY OF COMMENTS AND QUESTIONS RECEIVED IN WRITING DURING THE PUBLIC COMMENT PERIOD**

## RECORD OF DECISION

### BOARHEAD FARMS SUPERFUND SITE

#### PART II - DECISION SUMMARY

##### I. SITE NAME, LOCATION, AND DESCRIPTION

The Boarhead Farms Superfund Site (Site) is located in Bridgeton Township, Bucks County, Pennsylvania. The Site consists of approximately 120 acres on Lonely Cottage Road in Upper Black Eddy, in the western part of Bridgeton Township (Figure 1). Approximately one half of the Site is wooded and nonwooded wetlands. Other features of the Site include open field areas, four manmade ponds, wooded uplands, a farmhouse, office, and stable (Figure 2).

Aerial photographs indicate that the property was heavily wooded prior to 1969. In 1969 Manfred DeRewal Sr. (hereafter referred to as "Mr. DeRewal") incorporated Boarhead Corporation (BHC) and DeRewal Chemical Company (DCC) and acted as president of both companies. BHC purchased the Site in 1969 and remains the current legal owner. Keystone Excavation Company once leased a portion of the Site to store and maintain excavating and hauling equipment.

##### II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

Prior to his tenure at Boarhead Corporation, Mr. DeRewal operated the Revere Chemical Site in Revere, Bucks County, Pennsylvania from 1965 to 1969. The Pennsylvania Department of Environmental Resources (PADER), now known as the Pennsylvania Department of Environmental Protection (PADEP), ordered the Revere Site closed in 1970 due to numerous pollution violations. During legal proceedings, Mr. DeRewal claimed that he moved 260,000 gallons of "liquid waste" from Revere between July 17, 1970 and August 4, 1970. No documentation was available to indicate where the waste was disposed. The Boarhead Farms Site is four miles from Revere.

In the early 1970s, the Pennsylvania State Police began receiving complaints of dead fish, dead plant life, and foaming along the edges of a stream on property adjacent to the Boarhead Site. The complaint alleged that the pollution was caused by acid dumped into the stream from tank trucks at the Site. The Bucks County Department of Health (BCDOH) investigated the complaints and observed pungent odors at the Site. BCDOH also noted drums aboard an open trailer, unused drums awaiting burial, and large empty tanks awaiting removal. In addition, BCDOH reported a bulldozer onsite burying old drums. According to statements by Mr. DeRewal, the old empty drums were crushed and buried on the Boarhead Site property. BCDOH also noted that approximately 40 drums were filled with an unspecified solvent and staged above

ground. In addition, empty tanker trucks were parked on the Site. BCDOH attempted to inspect the Site further, but Mr. DeRewal denied access in the absence of a search warrant.

On March 5, 1973, BCDOH obtained a search warrant and inspected the Site. BCDOH's "Waste Discharge Inspection Report" recorded improperly stored chemicals resulting in the spillage of liquid and solid waste on the ground. Chemicals were observed leaking from 55-gallon drums, in waste pools along the access road, and in onsite lagoons and vats. Hazardous materials were also stored improperly in leaking drums and broken bags. Chemicals documented at the Site included copper ammonium sulfate, paint solvents, arsenic pentoxide, pesticides, and copper naphtholate. A BCDOH memorandum identified a cleared area northeast of the onsite office as the location of an unspecified amount of buried drums.

On March 21, 1973, BHC and Mr. DeRewal executed an agreement with PADER to address environmental conditions at the Site. It was agreed that all industrial and solid waste, buried drums, and contaminated soil would be removed from the Site. Storing of hazardous waste, landfilling operations and parking of tanker trucks were banned. In October 1973, however, a neighbor noticed discoloration and foaming in a stream on his property. BHC was found in violation of the Pennsylvania Clean Streams Law for releasing chemical waste without a permit. The contamination came from a leaking tanker truck carrying ferrous chloride. The truck had discharged its entire load, approximately 3,000 gallons of ferrous chloride, at the Site.

Groundwater and soil samples taken from the Site in July 1974 by a consultant hired by Boarhead Corporation revealed pH readings of 2.9. The presence of chloride, iron, chromium, copper, zinc, and nickel were also noted. In April 1976, approximately 4000 gallons of liquid ammonia were released from an open valve on a tanker truck. The ammonia odor was noted by BCDOH in the open fields, near the ponds, and on Lonely Cottage Road. In September 1976, a new complaint about an ammonia odor was reported. The Bridgeton Police Department arrived at the Site and found a strong ammonia smell and a heavy fog by a storage tank. The tank contained sulfuric acid and had developed a leak, creating a sulfuric mist. Thirty-four local residents were evacuated as a result.

On October 15, 1976, the Court of Common Pleas of Bucks County issued an order to Manfred DeRewal and Boarhead Corporation prohibiting all chemicals from entering the Site in amounts greater than necessary for normal household use. All chemicals on the property were ordered removed within seven days.

EPA conducted a site inspection (SI) of Boarhead Farms in May 1984 and issued a final SI report on January 20, 1986. EPA issued a Hazardous Ranking System (HRS) report on September 4, 1987. The HRS report scored the Site at 39.9. EPA placed the Site on the National Priorities List (NPL) on March 31, 1989. EPA conducted a Remedial Investigation (RI) and Feasibility Study (FS) for the Site. The RI was completed in January 1997. The Feasibility Study (FS) was

completed in July 1997. The Proposed Plan for comprehensive Site cleanup was issued in January 1998.

EPA has conducted three removal actions at the Boarhead Farms Site. During the first two, one each in 1992 and 1993, over 2500 buried drums were located, excavated and disposed of offsite, reducing the contaminant levels in the subsurface soils. The excavated areas were then covered with a layer of clean fill to reduce exposure risk. A third removal action to intercept, collect and treat contaminated groundwater in an onsite treatment facility is continuing at this time. The interception trench is approximately 1300 feet in length and is located downgradient from the high VOC and metals concentration areas. The trench intercepts the shallow and intermediate groundwater flowing through the Site and pumps it to an onsite treatment facility for removal of VOCs. In addition, residential wells where contamination was found have been equipped with granular activated carbon (GAC) filters.

A fourth removal action was performed by General Ceramics, Inc. (GCI) pursuant to an Administrative Order by Consent dated December 11, 1992 (EPA Docket No. III-92-66-DC). GCI excavated and removed drums and soils contaminated with radioactive wastes. EPA has determined that all known radioactive wastes have been removed from the Site.

### **III. HIGHLIGHTS OF COMMUNITY PARTICIPATION**

The documents which EPA used to develop, evaluate, and select a remedy for the Site have been maintained at the Bucks County Library Center, 150 S. Pine Street, Doylestown, PA and at the EPA Region III Office, Philadelphia, PA.

The Proposed Plan was released to the public on January 5, 1998. The notice of availability for the RI/FS and Proposed Plan was published in the January 5 and 9, 1998 editions of *The Intelligencer Record* and *The Morning Call*, as well as in the January 8, 1998 edition of *The Delaware Valley News*. A 30-day public comment period began on January 5, 1998 and was initially scheduled to conclude on February 4, 1998. By request, the public comment period was extended until April 5, 1998.

A public meeting was held during the public comment period on January 14, 1998. At the meeting, representatives from EPA answered questions about the Site and the remedial alternatives under consideration. Approximately 30 people attended the meeting, including residents from the impacted area, potentially responsible parties, and news media representatives. A summary of comments received during the comment period and EPA's responses are contained in Part III of this document.

#### **IV. SCOPE AND ROLE OF RESPONSE ACTIONS**

This final selected remedy addresses the threats posed by the release of hazardous substances at the Site. The primary objective of the remedy described in this ROD is to reduce or eliminate the potential for human and ecological exposure to contamination at the Site. The selected remedy outlined on pages 30 to 42 of this ROD will comprehensively address the risks posed by the release or threat of release of hazardous substances from the Site.

#### **V. SUMMARY OF SITE CHARACTERISTICS**

##### **A. Topography**

The Site is located in western Bridgeton Township, Bucks County which is in the Triassic Lowland section of the Piedmont Physiographic Province. The Triassic Lowlands are characterized by sedimentary rocks of the Newark Supergroup and diabase intrusions. The sedimentary rocks are primarily continental sandstones and shales, having since eroded to lowlands. The depth to bedrock varies across the Site, but generally the overburden thickness increases downslope from the topographic highs on the western and northern parts of the Site. The overburden thins across a broad low-lying area in the eastern part of the Site.

The Site occupies approximately 120 acres. Half of the area consists of wooded and nonwooded wetlands, with the remainder being wooded uplands, open fields and ponds. The topography of the Site is rolling and hilly. The property slopes gently east at a grade of four percent, from a high of 625 feet above Mean Sea Level (MSL) at the western edges to a low of 540 feet MSL along Lonely Cottage Road.

##### **B. Climate**

The Boarhead Farms Site is in the northeastern part of Bucks County, which is part of the Southeast Piedmont climatic division. The climate is classified as humid continental, modified by the Atlantic Ocean. The annual average temperature for most of Bucks County is 53°F. Annual average precipitation is between 43 to 45 inches. Summer rainfall is generally in the form of thundershowers, occurring on an average of 21 days from June through August. The annual average snowfall for most of Bucks County is 30 inches. Snow cover is more frequent and remains for longer periods of time on north and east facing slopes. According to the U.S. Department of Agriculture, the growing season is 155 days.

##### **C. Hydrology**

There are three hydrogeologic systems at the Site: 1) the shallow groundwater system within the soil, saprolite, weathered bedrock, and moderately fractured shallow bedrock, 2) the intermediate



groundwater system within the deep-diabase bedrock, and 3) the deep groundwater system within the Triassic shale of the Newark Supergroup.

The water table in the shallow groundwater system is a subdued representation of the topography. The groundwater in the shallow system flows east from the topographic highs in the western part of the Site toward the former drum-burial areas in the central part of the Site and then toward the wooded wetlands to the north and south of the access road. A groundwater divide parallels the access road in the eastern part of the Site. The hydraulic gradient in the shallow system is steepest in the southwest, near the topographic highs, and flattens as the groundwater moves east across the Site. The groundwater flow velocity is expected to range from 1.2 to 364 feet per year beneath the steeper parts of the Site and from 41 to 226 feet per year beneath the wetlands.

Streams and ponds lose water to the shallow groundwater system in summer when groundwater levels drop, and gain water in winter when groundwater levels rise. When groundwater levels are high, the flow off the Site is generally intercepted by surface streams.

Groundwater flow in the intermediate system is primarily through a series of fractures in the deep-diabase bedrock. Limited data suggest that groundwater flows laterally from the former drum-burial areas on the Site toward Lonely Cottage Road.

The deep groundwater system has little to no flow since it consists mainly of the underlying competent bedrock. Literature suggests that the flow in the Triassic shale is primarily in the direction of strike through fractures, bedding planes, and joints. The flow in the deep system has local and regional components due to pumping and fracture distribution, but generally is toward points of regional discharges, such as the Delaware River.

Free hydraulic connection exists through vertical fractures between the overburden and the shallow weathered diabase. Since the hydraulic head in the deep groundwater system (i.e., the Triassic shales) is lower than that of the shallow system, there is a potential for groundwater in the shallow system to flow downward. Fractures which would allow downward flow, however, are limited. Shallow groundwater may reach into the Triassic shale downgradient wells, such as those residential wells east and northeast of the Site, since long open boreholes exist and may connect the shallow and deep groundwater systems. Hydraulic interconnection between the diabase and the Triassic shale is more likely to occur at the edges of the diabase than in its interior.

#### **D. Land Use**

The land use in the vicinity of the Site is primarily residential. Two junkyards south and northwest of the property are the sole known industrial facilities in the immediate area. Several parcels of Pennsylvania State Gamelands are within 0.5 miles of the Site. Two of the properties bordering the Site, the Bridgeton Township Sportsman Association (gun club) and Camp Davis (church camp), are recreational facilities. Bridgeton Elementary School and Bridgeton Athletic Association ballfields are within one mile of the Site (Figure 3).

## VI. NATURE AND EXTENT OF CONTAMINATION

This section discusses the nature and extent of contamination of surface and subsurface soils, groundwater, surface water, sediment, air, and hot spot areas. In order to conduct Site investigations accurately, the Site was divided into areas based on geographic features and suspected waste-disposal activities (Table 1 and Figure 2).

The media were assessed by collecting environmental samples. Analytical data were reviewed for conformance with usability standards. Usable data were evaluated for distribution of contaminants and were compared with potentially applicable standards. The assessment focused on contaminants of potential concern (COPCs) identified in the risk assessment for surface soil, surface water, sediment, and groundwater. For soil, COPCs selected for assessment were based on their potential for leaching to groundwater. Observed concentrations of chemicals were compared with Site-specific risk-based concentrations (RBCs) for surface soil, surface water and sediment; to maximum contaminant levels (MCLs); to PADER health advisory limits (HALs) (Table 2); Site-specific RBCs for groundwater; and to Site-specific preliminary remediation goals (PRGs) for groundwater and soil (Tables 3 and 4). PRGs are site-specific numbers modeled on the basis of possible effects of the COPCs on both human and ecological receptors.

### A. Surface Soil

Surface soil was sampled on a regularly spaced grid pattern throughout the Site. Sampling was followed by delineation of hot spots at grid nodes where preliminary action levels were exceeded or more than one organic contaminant was detected during the grid sampling.

#### Inorganic

Inorganic contaminants of concern were found in the surface soils of the open field areas, eastern wooded wetlands, and western wooded uplands. These included arsenic (ranging from 1.3 - 11.2 milligrams per kilogram (mg/kg)), beryllium (ranging from 0.14 - 17.3 mg/kg), cadmium (ranging from 0.34 - 21.5 mg/kg), chromium (ranging from 15.5 - 812.0 mg/kg), copper (ranging from 5.6 - 396.0 mg/kg), and thallium (ranging from 0.48 - 3.30 mg/kg). These concentrations exceeded the human health RBCs for all areas in which they were detected.

#### Semivolatile Organic Compounds (SVOCs)

Bis(2-ethylhexyl)phthalate was the only SVOC of concern in the surface soils. Concentrations were found at a range from 120.0 - 28,000 ug/kg (micrograms per kilogram).

### Volatile Organic Compounds (VOCs)

The VOCs detected in the open field areas are associated with the former drum burial areas or where surface water from the areas is directed. Moderate to extremely elevated levels of VOCs which EPA determined were COPCs were detected in samples from the wooded wetlands associated with test pits. The COPCs in all areas of the surface soils onsite include TCE (ranging from 2.0 - 1000.0 ug/kg), 1,1,1-TCA (ranging from 4.0 - 120.0 ug/kg), cis-1,2-DCE (ranging from 2.0 - 66.0 ug/kg), PCE (ranging from 2.0 - 16.0 ug/kg), and toluene (ranging from 1.0 - 32.0 ug/kg). Other COPCs in the surface soils include benzene, ethylbenzene, xylenes, and methyl isobutyl ketone (MIBK).

### **B. Subsurface Soil**

Subsurface soils were sampled to evaluate the nature and extent of contamination around the former drum-burial areas in the open fields and wetlands. Distribution of the contaminants do not suggest a continuous area of contamination, but rather the presence of smaller "hot spots." Figure 4 shows test pit locations and Figure 5 shows the distribution of contaminants in soil (both surface and subsurface soil).

### Inorganics

Subsurface soils collected from the open field areas showed high levels of the inorganic metals cadmium (ranging from 0.25 - 423 mg/kg) and lead (ranging from 1.5 - 11,800 mg/kg). Both cadmium and lead were detected in the areas associated with test pit locations throughout the open fields. Cadmium concentrations up to about 50 milligrams per kilogram (mg/kg) and lead concentrations up to 93 mg/kg were found near the farmhouse.

### SVOCs

Bis(2-ethylhexyl)phthalate was the only SVOC found above Preliminary Remediation Goals (PRGs) in the subsurface soil. The concentrations of bis(2-ethylhexyl)phthalate ranged from 42 to 100,000 ug/kg in the open field areas.

### VOCs

VOCs were detected at high levels throughout the subsurface soils in the open field areas. TCE was detected up to 2,200,00 ug/kg, PCE up to 15,000 ug/kg, and 1,1,1-TCA up to 94,000 ug/kg. In addition, benzene was detected near the farmhouse at concentrations up to 113 ug/kg. The areas with high TCE and benzene concentrations have been designated as soil "hot spots" since

no specific plume has been identified. The PRGs for TCE, PCE, and 1,1,1-TCA were also exceeded in Wetland Area 3.

Subsurface soil samples were collected from Wetland Area 12 to investigate past disposal activities in the wetland and to delineate contamination detected during sediment sampling. PRGs were not exceeded for organic or inorganic contaminants in the subsurface soil samples collected in Wetland Area 12.

### **C. Surface Water**

Surface water and sediment samples were collected from the four onsite ponds, two onsite wetland areas, and the unnamed creek, and were compared with those from an offsite pond, wetland, and creek to determine background concentrations.

#### **Inorganics**

RBCs were exceeded for manganese, detected up to 6.360 mg/l, and chromium, detected up to 1.870 mg/l, in Wetland Area 12. These exceedances do not, however, pose a risk to human health according to the Site-specific human health risk assessment. Human health RBCs were not exceeded in surface water samples from Wetland Area 3.

Manganese (ranging from 0.043 - 2.91 mg/l) was found in surface water samples collected in three culverts that drain Wetland Area 12. These exceedances pose no risk to human health based on the Site-specific human health risk assessment.

#### **SVOCs**

Nitrobenzene was the only significant SVOC detected in onsite surface water samples. Levels of nitrobenzene were found in Pond 11 ranging from 3.0 - 6.0 ug/l.

#### **VOCs**

Low levels of the VOCs 1,1,1-TCA (ranging from 6.0 - 10.0 ug/l), 1,2-DCE (ranging from 5.0 - 15.0 ug/l), and TCE (ranging from 5.0 - 17.0 ug/l), were detected in the surface water samples collected from onsite Ponds 10 and 11. The highest concentrations of organics were detected in surface water samples collected along the northern edge of Pond 11 and a drainage channel adjacent to the pond. However, Pond 11 was drained into Wetland Area 12 in the spring of 1993 and has since refilled from precipitation, surface runoff, and groundwater seepage.

Low levels of the VOCs 1,1,1-TCA, 1,2-DCA, 1,2-DCE, PCE, and TCE were detected in surface water samples collected from the wetlands in the area downgradient of former drum-burial areas,

and in one culvert that drains Wetland 12. Human health RBCs were not exceeded for these detections.

#### **D. Sediment**

Sediment samples were taken from the onsite ponds and wetlands, as well as from the area culverts and creeks.

##### Inorganics

RBCs for four inorganic compounds were exceeded in the sediment samples from the onsite Ponds 9, 10, and 11. These include detections of arsenic up to 25.6 mg/kg, beryllium up to 5.1 mg/kg, chromium up to 617.0 mg/kg, and nickel up to 2650.0 mg/kg. In addition, chromium was detected up to 1180 mg/kg in sediment samples from Wetland Area 3.

##### SVOCs

No SVOCs were classified as COPCs for the sediment samples taken throughout the Site.

##### VOCs

Elevated levels of 1,1,1-TCA (up to 6 ug/kg), 1,1-DCA (up to 100 ug/kg), 1,2-DCE (up to 13 ug/kg), toluene (up to 13 mg/kg), and TCE (up to 1180 ug/kg) were detected in sediment samples collected from Pond 10. In addition, VOCs were found along the northern and eastern edges of Pond 11, immediately downgradient from drum-burial areas.

Wetland Areas 3 and 12 showed low levels of VOCs, such as 1,1,1-TCA, 1,2-DCE, toluene, vinyl chloride, PCE and TCE. Low levels of acetone and pesticides were detected in samples collected from culverts and creeks associated with the wetland areas; however, these levels did not exceed RBCs.

#### **E. Groundwater**

Groundwater quality was investigated in two groundwater systems at the Site -- the shallow groundwater system (overburden and shallow diabase) and the intermediate groundwater system (deep diabase). Groundwater quality for the deep groundwater system (Triassic shale) was not investigated, since the underlying bedrock is considered competent. Data indicate that there is little flow between the shallow and intermediate systems. Figure 4 shows monitoring well locations, and Tables 2 and 6 list the specific MCLs that were exceeded in each Site well and residential well, respectively.

Select residential wells were sampled during nine separate sampling events between November 1990 and January 1995. MCLs were exceeded in 22 residential wells for at least one contaminant. Table 6 summarizes residential wells with MCL exceedances and Figure 6 shows residential well locations.

### Inorganics

Wells in the shallow groundwater system throughout the Site showed various levels of inorganic contaminants exceeding MCLs. These detections include chromium up to 22.8 ug/l, nickel up to 6.68 ug/l, manganese up to 69.20 ug/l, and cadmium up to 1.84 ug/l. In addition, levels of lead, thallium, antimony, and beryllium exceeded MCLs and are cause for concern. The majority of the high contamination levels coincide with the contaminated subsurface soils related to the buried drums found in both the open field and wetland areas.

The intermediate groundwater system showed detections offsite of chromium, lead and nickel in concentrations just above the MCL. These offsite elevated levels were found sporadically throughout the study area and are not believed to be Site-related. The samples taken during the RI/FS in the residential wells had detections of antimony, chromium, thallium, nickel, cadmium, and lead. The samples taken during the RI investigation showed sixteen residential wells with detections of at least one inorganic contaminant above the MCL.

### SVOCs

The SVOC nitrobenzene was detected in levels up to 130 ug/l in the shallow groundwater system in the open field areas. Low levels of additional SVOCs were also found in areas throughout the Site.

Bis(2-ethylhexyl)phthalate was the organic compound detected most often in the residential wells at concentrations up to 32 ug/l. The affected residential wells have been equipped with GAC filtration units for removal of all organics.

### VOCs

Wells in the shallow groundwater system had extremely high concentrations of VOCs that exceeded MCLs. These include detections of PCE up to 20,000 ug/l, TCE up to 260,000 ug/l, benzene up to 300,000 ug/l, 1,1,1-TCA up to 140,000 ug/l, cis-1,2-DCA up to 53,000 ug/l, 1,2-DCE up to 35,000 ug/l, 1,2 - DCA up to 4700 ug/kg, vinyl chloride up to 910 ug/l, xylenes up to 7000 ug/l, and toluene up to 48,000 ug/l. Other VOC detections include 1,1,2-TCA, 1,1-DCE, 1,2-dichlorobenzene, 1,2-DCP, trans-1,2-DCE, MIBK, carbon tetrachloride, ethylbenzene, and

methylene chloride. Low levels of other VOCs and pesticides were also detected. The areas of high levels of shallow groundwater contamination include Area 2 near the farmhouse and open field Areas 1, 5, and 6, coinciding with the former drum burial areas. In addition, the downgradient wetlands had high levels of TCE.

Carbon disulfide, cis-1,2-DCE, lead, 1,1,2-TCA, TCE, 1,1-DCE, and PCE were the VOCs detected in the intermediate groundwater system.

#### **F. Hot Spots**

Based on the results of the subsurface soil and groundwater investigations, three areas of particular concern, or hot spots, were identified. These are areas where free product (LNAPL or DNAPL) is suspected based on high concentrations of contaminants detected in the soil and groundwater samples in the area, or visual observation of free product during drum removal. Figure 7 shows the approximate location and aerial extent of the hot spot areas. The actual extent of the hot spot contamination will be determined in the design process.

Hot Spot 1 is in a wetland area where excavation of drums containing contaminated materials occurred during the removal actions. Extremely high levels of TCE and high levels of PCE and 1,1,1-TCA were detected in the soil following drum removal. Groundwater from the area showed high levels of TCE, 1,1,1-TCA, cis-1,2-DCE, 1, 2-DCA, and vinyl chloride.

Hot Spot 2, located to the south of the farmhouse, yielded high levels of benzene in soil samples, increasing with depth. Benzene was also detected in the groundwater at concentrations up to 300,000 ug/L.

Hot Spot 3 is a smaller area located to the northwest of the farmhouse and showed high concentrations of TCE, 1,1,1-TCA, cis-1,2-DCE, and PCE in the soil.

#### **G. Buried Drums**

In 1992 and 1993, EPA removed more than 2500 buried drums from 40 locations in the open field area at the Boarhead Farms Site. While a significant number of buried drums are believed to have been removed during this effort, some buried drums still remain. Following completion of the drum removal action, EPA conducted a magnetometer survey to identify remaining subsurface magnetic anomalies.

The results of the survey indicated a significant number of magnetic anomalies. Approximately 20 anomalies measured greater than 200 gammas, and most likely represent both fully intact drums and/or empty crushed drums.

## H. Air

EPA performed air monitoring for health and safety purposes only. Air was monitored at well heads, in the head space of samples, and in the breathing zone during well installation and sampling activities. Monitoring was performed using photo ionization detectors (PIDs), flame ionization detectors (FIDs), combustible gas indicators (CGIs), and oxygen meters. Instrument readings were recorded in field books documenting each activity. Since most of the contamination at the Site is subsurface in the soil and groundwater, air was not an evaluated pathway and is not a concern at the Site.

## VII. SUMMARY OF SITE RISKS

Following completion of the Remedial Investigation, EPA conducted analyses to estimate the human health and environmental hazards that could result if contamination at the Site is not addressed. These analyses are commonly referred to as risk assessments and identify existing and future risks that could occur if conditions at the Site do not change. The Baseline Human Health Risk Assessment (BLRA) evaluated human health risks posed by the Site and the Ecological Risk Assessment (ERA) evaluated environmental impacts from the Site.

### A. Human Health Risks

The BLRA assesses the toxicity, or degree of hazard, posed by contaminants related to the Site and involves describing the routes by which humans could come into contact with these substances. Separate calculations are made for those substances that are carcinogenic (cancer causing) and for those that are non-carcinogenic (but can cause other adverse health effects).

The primary objective of the BLRA was to assess the health risks to individuals who may have current and future exposure to contamination present at and migrating from the Site under existing Site conditions. The BLRA is comprised of the following components:

- *Identification of Chemicals of Potential Concern (COPCs)* - identification and characterization of the distribution of COPCs found onsite.
- *Exposure Assessment* - identification of potential pathways of human exposure, and estimation of the magnitude, frequency, and duration of these exposures.
- *Toxicity Assessment* - assessment of the potential adverse effects of the COPCs.
- *Risk Characterization* - characterization of the potential health risks associated with exposure to Site-related contamination.



Each of these steps is explained further below.

### *1. Identification of COPCs*

The identification of COPCs includes data collection, data evaluation, and data screening steps. The data collection and evaluation steps involve gathering and reviewing the available Site data and developing a set of data that is of acceptable quality for risk assessment. This data set is then further screened to determine those chemicals and media of potential concern. The data used for the quantitative risk analysis were all validated prior to use in the risk assessment.

#### Sediment and Surface Water

Samples were collected from the four onsite ponds (PD-8, PD-9, PD-10, and PD-11). In addition, surface water and sediment samples were collected from Wetland Areas 3 and 12. Samples from Pond 11 (PD-11) were collected before the pond was drained for drum removal. Samples of offsite sediment and surface water were collected from the unnamed creek and the nearby culverts.

#### Surface Soil

A grid pattern was set up in the open field areas to evaluate surface soil contamination. Samples were collected from depths of 0 to 6 inches, and subsurface samples were collected from 30 to 36 inches. Each sample was analyzed for target metals and VOCs. Hot spots were determined by identifying areas with concentrations above EPA Region III Risk Based Concentrations (RBCs) for residential soil. Shallow soil samples were collected in the wooded wetlands and wooded uplands areas.

#### Groundwater

Groundwater beneath the Site is monitored through 35 monitoring wells. Shallow groundwater in the 29 overburden and upper-dabase wells were considered in the RA. MW-9 and MW-11 were used as background wells. Generally, groundwater around former drum-burial areas marks the center of the contaminant plumes and wells MW-12, MW-16, MW-20, MW-21, and MW-23 show the highest concentrations of most analytes.

Two residential wells are on the Site -- one 150-foot shallow well (RW-10) adjacent to the farmhouse and one 700-foot deep well (RW-46) associated with Keystone Excavation Building. The data on RW-10 indicate the presence of site-related contaminants; therefore RW-10 was included for further analysis in the RA.

Offsite residential wells have routinely been sampled since 1989. An analysis of possible human health risks was performed for the data related to these wells. Granular activated carbon (GAC) filters have been installed on affected downgradient wells and are monitored regularly.

### Background Samples

Nine background soil samples were collected from offsite soil borings and analyzed. Seven of the samples were collected from the surface (0 to 6 inches) and two were collected from the subsurface (30 to 36 inches). Background samples of sediment and surface water were collected from the reference creek (UC00), reference pond (PD00), and reference wetlands (WT00).

### Selection of Chemicals of Potential Concern

The COPC selection process was conservative to ensure selection of the most constituents. Selection of COPCs was based on the criteria presented in EPA Region III guidelines. The maximum concentration of each detected constituent in each of the media was compared to the following criteria to select the COPCs for a specific area. If the maximum concentration of a constituent exceeded each of the criteria, the constituent was selected as a COPC.

- *Comparison with Health-Based Criteria:* The maximum detected chemical concentrations in groundwater and soil were compared with EPA Region III risk-based concentrations (RBCs) which were developed using current toxicity factors in the exposure formula. These screening level RBCs were based on a target hazard index of 1.0 and a target cancer risk of  $1 \times 10^{-6}$ . The RBCs for recreational and residential exposure to surface soil included both inhalation and ingestion route RBCs. The RBCs for residential groundwater exposure were based on ingestion of groundwater and inhalation of volatiles from groundwater. The RBCs for recreational exposure to soil were calculated using exposure factors for the residential scenario. The RBCs for groundwater exposure for a site worker were also calculated using residential scenario factors, and the RBCs for the soil exposure scenario for a site worker were calculated by using site worker exposure factors. Chemicals detected below these Site-specific RBC values were eliminated from the COPC list.
- *Comparison with Background Samples:* The 95 percent upper tolerance limit (95% UTL) was calculated for each inorganic constituent detected in the set of background soil, sediment, and surface water samples. For potential source areas where the maximum detected concentration was greater than the background 95% UTL (or the maximum background concentration if the 95% UTL is greater than the maximum), the inorganic constituent was retained as a COPC. For groundwater, the maximum inorganic-chemical concentrations in the background

samples were compared with the maximum detected concentrations in the Site samples, as all inorganic levels in the Site samples were above the background levels. All inorganics were retained for further analysis in the RA.

- *Comparison with Recommended Dietary Allowances (RDAs):* Chemicals which are human nutrients, present at low concentrations (i.e., only slightly elevated above naturally occurring levels), and toxic only at very high doses were eliminated from the quantitative risk analysis. These constituents are calcium, iron, magnesium, potassium, and sodium. All of the human nutrients detected in groundwater and surface soil were below the RDAs, with the exception of iron ingestion from groundwater from monitoring wells MW-16, MW-20, MW-21, MW-12, and MW-23 by children and adults and iron ingestion from open-area soil by children. However, iron was not selected as a COPC since the RDA was only slightly exceeded for soil.

### Chemicals of Potential Concern

Table 7 identifies the chemicals that were selected as COPCs based on the above screening methodology for the surface soil, shallow groundwater, pond sediment and pond surface water areas.

A detailed evaluation of all chemicals exceeding risk screening criteria is presented in the Baseline Risk Assessment of the Remedial Investigation Report.

## **2. Exposure Assessment**

An exposure assessment involves three basic steps: 1) identifying the potentially exposed populations, both current and future; 2) determining the pathways by which these populations may be exposed; and 3) quantifying the exposure. Under current Site conditions, the BLRA identified potential populations as having the potential for exposure to Site-related contaminants, either currently and/or in the future. The migration pathways for the contamination from the source areas include volatilization of the VOCs from soil, subsurface soil, and groundwater; downward migration of the VOCs from soil to the groundwater; lateral downgradient transport of VOCs in the groundwater; and ingestion of contaminants by aquatic organisms.

### Current Land Use

The farmhouse continues to serve as a residence, although the exact number and age of people living in the house appears to fluctuate with time. The Keystone Excavating Company appears to be performing some operations in the large garage in the back of the property. The Site is not separated from surrounding land and is readily accessible to the public under current conditions.

Hunters have been observed on the Site and onsite residents use the large ponds for recreational activities such as swimming and fishing.

### Potential Future Uses

The Site is in a rural residential area. EPA expects that future land use in the area will be similar to present land use. Possible trends include more extensive residential and/or commercial development. Such activity would potentially expose increased numbers of residents and/or workers to contaminated areas and might result in increased use of onsite groundwater. The ponds, wetlands, and culverts would likely be used by residents and visitors for recreation.

### *3. Toxicity Assessment*

The purpose of the toxicity assessment is to weigh available evidence regarding the potential for particular contaminants to cause adverse effects in exposed individuals. Where possible, the assessment provides a quantitative estimate of the relationship between the extent of exposure to a contaminant and the increased likelihood and/or severity of adverse effects.

A toxicity assessment for contaminants found at a Superfund site is generally accomplished in two steps: 1) hazard identification, and 2) dose-response assessment. Hazard identification is the process of determining whether exposure to an agent can cause an increase in the incidence of a particular adverse health effect (e.g., cancer or birth defects) and whether the adverse health effect is likely to occur in humans. Hazard identification further involves characterizing the nature and strength of the evidence of causation.

Dose-response evaluation is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose of the contaminant administered or received and the incidence of adverse health effects in the administered population. From this quantitative dose-response relationship, toxicity values (e.g., reference doses and slope factors) are derived that can be used to estimate the incidence of or potential for adverse effects as a function of human exposure to the agent. These toxicity values are used in the risk characterization step to estimate the likelihood of adverse effects occurring in humans at different exposure levels.

For purposes of the risk assessment, contaminants were classified into two groups -- potential carcinogens and noncarcinogens. The risks posed by these two types of compounds are assessed differently because noncarcinogens generally exhibit a threshold dose below which no adverse effects occur, while no such threshold can be proven to exist for carcinogens. As used here, the term carcinogen means any chemical for which there is sufficient evidence that exposure may result in continuing uncontrolled cell division (cancer) in humans and/or animals. Conversely, the term noncarcinogen means any chemical for which the carcinogenic evidence is negative or insufficient.

Slope factors have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic contaminants of concern. Slope factors, which are expressed in units of mg/kg/day are multiplied by the estimated intake of a potential carcinogen, in mg/kg/day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper-bound" reflects the conservative estimate of the risks calculated from the slope factor. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Slope factors are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied to account for the use of animal data to predict effects on humans. Slope factors used in the baseline risk assessment are presented in Table 8.

Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to contaminants of concern exhibiting noncarcinogenic effects. RfDs, which are expressed in units of mg/kg/day, are estimates of acceptable lifetime daily exposure levels for humans. Estimated intakes of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors help ensure that the RfDs will not underestimate the potential for adverse noncarcinogenic effects to occur. Reference doses used in the baseline risk assessment are presented in Table 8.

#### *4. Human Health Effects*

Toxicological profiles of selected constituents, including TCE, vinyl chloride, 1,1-Dichloroethene, cis-1,2-Dichloroethene, trans-1,2-Dichloroethene, Tetrachloroethene, 1,1,1-Trichloroethane, Benzene, 1,2-Dichloropropane, Ethyl Benzene, Toluene, Nitrobenzene, Arsenic, Aluminum, Antimony, Beryllium, Cadmium, Chromium, Manganese, Nickel, Thallium, and Zinc can be found in Appendix A.

#### *5. Risk Characterization*

The risk characterization process integrates the toxicity and exposure assessments into a quantitative expression of risk. For carcinogens, the exposure point concentrations and exposure factors discussed earlier are mathematically combined to generate a chronic daily intake value that is averaged over a lifetime (i.e., 70 years). This intake value is then multiplied by the toxicity value for the contaminant (i.e., the slope factor) to generate the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the contaminant. The NCP establishes acceptable levels of carcinogenic risk for Superfund Sites ranging from one excess cancer case per 10,000 people exposed to one excess cancer case per one million people exposed. This translates to a risk range of between one in 10,000 and one in one million

additional cancer cases. Expressed as scientific notation, this risk range is between  $1.0\text{E}-04$  and  $1.0\text{E}-06$ . Remedial action is warranted at a Site when the calculated cancer risk level exceeds  $1.0\text{E}-04$ . However, since EPA's cleanup goal is generally to reduce the risk to  $1.0\text{E}-06$  or less, EPA also may take action where the risk is within the range between  $1.0\text{E}-04$  and  $1.0\text{E}-06$ .

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (i.e., the chronic daily intake) with the toxicity of the contaminant for a similar time period (i.e., the reference dose). The ratio of exposure to toxicity is called a hazard quotient. A Hazard Index (HI) is generated by adding the appropriate hazard quotients for contaminants to which a given population may reasonably be exposed. The NCP also states that sites should not pose a health threat due to a non-carcinogenic, but otherwise hazardous, chemical. If the HI exceeds one (1.0), there may be concern for the potential non-carcinogenic health effects associated with exposure to the chemicals. The HI identifies the potential for the most sensitive individuals to be adversely affected by the noncarcinogenic effects of chemicals. As a rule, the greater the value of the HI above 1.0, the greater the level of concern.

## **B. Ecological Risk Assessment**

The ecological risk assessment was designed to evaluate the potential threats to ecological organisms from exposure to Site contaminants and to establish potential Site-specific cleanup level(s) for the contaminants of concern. The evaluation was made by defining Site characteristics, potential ecological receptors, contaminants of concern, and pathways potentially applicable to the ecological resources. The risk characterization is based on complete pathways and a comparison of concentrations of contaminants at the Site and concentrations associated with adverse effects. In a screening level assessment, ecological benchmarks for contaminants of concern are derived from the literature and are compared with the onsite concentrations. The potential for risks within each habitat area were based on an assessment of the environmental effects quotient (EEQ) for each contaminant and a comparison of the contaminant concentrations and background levels. The EEQ approach is considered protective of ecological resources since the onsite contamination levels in the specific medium are compared with literature values on the basis of the most sensitive receptor for that medium.

Major habitats at the Site include ponds, wooded wetlands, emergent wetlands, wooded uplands, and open fields. Wildlife observed on and near the Site include a variety of birds, mammals, reptiles, and amphibians. No state or federally listed threatened or endangered species were observed on or near the Site.

The analyses in the Ecological Assessment indicated that certain contaminant levels in sediment and soil at the Site are higher than background levels and ecological criteria. Several contaminants that occur throughout the Site were identified as COPCs. These COPCs within

sediment and surface soil appear to pose a potential risk to ecological resources. Concentrations in the surface water did not appear to pose a significant ecological risk.

In order to better define the Site-specific ecological risk potential, bioassay tests were performed using Site soils and sediments. The bioassay test for surface soils focused on mortality and growth of earthworms following a 14-day exposure to the soils. The bioassay test for sediments focused on mortality and growth of midges (*Chironomus tentans*) and amphipods (*Hyaella azteca*) following a 10-day exposure to the sediments. Surface soil samples were taken from locations in the upland and forested wetlands. These tests provide information on the direct toxicity of the soils and sediments to the test organisms and the data can be extrapolated to other invertebrate species that may inhabit the uplands and wetlands of the Site.

Sediment samples were collected from the onsite ponds and the forested and emergent wetlands. The survival and rate of growth (both weight and length) of earthworms, amphipods, and midges were compared to those who were exposed to soils and sediments collected from a reference site. Statistical analyses indicated that there was no reduction in the survival or growth of organisms exposed to Site sediments and surface soils. Therefore, the bioassay results indicate that the presence of contaminants in the surface soil and sediment do not pose a risk to the ecological resources at the Site.

### **C. Conclusions**

For ingestion, dermal contact, and inhalation of surface soil, surface water, and sediment, considering both current and future uses, human health risks to Site workers, residents, and recreational users do not exceed the acceptable limits of 1 to 100 in a million for carcinogenic risk; nor do they exceed the HI of 1.0 for noncarcinogenic risk.

Risk evaluation for groundwater indicates significant health risks if onsite groundwater is used for potable purposes. For current and future use, human health risks to Site workers, Site residents, and Site recreational users from shallow groundwater were evaluated for the pathways of ingestion, dermal contact, and inhalation. These risks exceeded the acceptable limits for carcinogenic risks as well as the HI for noncarcinogenic risk. VOC and metals contamination in the shallow groundwater contribute the most to the unacceptable risk levels.

Risk evaluation for offsite groundwater indicates potential health risks significantly above acceptable levels. Health risks to current residents downgradient from the Site were evaluated for the pathways of ingestion, dermal contact, and inhalation. Residential risk in 17 of the 26 residential wells evaluated in the residential groundwater exposure assessment present either an HI greater than 1 or carcinogenic risks greater than 100 in a million. These risks, however, have been mitigated through the installation of granular activated carbon (GAC) filter systems placed on the affected residential wells.

A summary of the human health risks present at the Boarhead Farms Site is presented in Table 9.

For the ecological portion of the BLRA, the analysis indicates that certain background contaminant levels in sediment and soil within the Site are higher than background levels and ecological criteria. Several contaminants were identified as ecological contaminants of concern (COCs) and could pose a potential risk to ecological resources. Site specific bioassay results were performed on surface soil and sediment samples. The bioassay results indicate that the presence of contaminants in the surface soil and sediments do not pose a risk of harm to ecological resources at the Boarhead Farms Site.

### **VIII. DESCRIPTION OF REMEDIAL ALTERNATIVES CONSIDERED FOR THE SITE**

The Feasibility Study (FS) identified a series of alternatives to address the subsurface soil and groundwater at the Boarhead Farms Site. Six alternatives were identified as possible response actions. These alternatives, described below, are numbered to correspond with alternatives found in the FS. For a summary of the alternatives, see Table 10.

#### **Alternative 1: No Action**

**Capital Cost** \$0  
**Total Present Worth Cost** \$0  
**Operation & Maintenance (O&M)(30 yr)** \$0/yr

The NCP requires that EPA consider a "No Action" alternative for every Superfund Site to establish a baseline or reference point against which each of the remedial action alternatives are compared. Under the "No Action" alternative, the current groundwater treatment system, which is currently being funded by EPA as a removal response action, would be shut down and no further monitoring or maintenance would take place onsite nor at the surrounding affected residential wells. All current and potential future risks would remain.

#### **Alternative 2: Continued Maintenance and Monitoring of the Existing Groundwater Interceptor Trench, Treatment Facility, and Residential Well GAC Filters; Institutional Controls**

**Capital Cost** \$960,000  
**Total Present Worth Cost** \$3,000,000  
**Operation & Maintenance (O&M)(30 yr)** \$130,000/yr

Under this alternative, the existing interceptor trench and groundwater treatment facility would continue to be operated and maintained. No other remediation would take place on the Site. The



cost for this alternative includes amounts required to maintain the existing interceptor trench, groundwater treatment facility, and carbon filters previously installed on selected residential wells. Institutional controls would be added to protect the integrity of the interceptor trench by restricting construction, excavation, regrading, and other activities in the area near the trench.

Since hazardous substances would be left onsite, a review of Site conditions would be required no less often than every five years pursuant to Section 121 (c) of CERCLA, 42 U.S.C. § 9621(c).

**Alternative 3:            Soil Excavation, Multilayer Cap; Excavation and Offsite Disposal of Buried Drums; Groundwater Extraction, Metals Precipitation, and Air Stripping; Institutional Controls and Monitoring; and Residential Water Treatment**

**Capital Cost                            \$5,200,000**  
**Total Present Worth Cost    \$11,690,000**  
**Operation & Maintenance (O&M)(30 yr)   \$420,000/yr**

This alternative combines the excavation of contaminated soil and buried drums with offsite disposal and capping of the contaminated central area (Areas 5 and 6). All contaminated soils, the aerial extent of which is approximated in Figure 5, would be excavated down to a level where all contaminants of potential concern (COPCs) are below the risk-based concentrations (RBCs) identified in the risk assessment for the Boarhead Farms Site. These soils would be tested to determine whether they exhibit hazardous characteristics in accordance with RCRA, treated as required, and placed in a central area where a geomembrane cap would be constructed to prevent discharge of contaminants into the groundwater. The cap would be surrounded by perimeter fencing to restrict access to contaminated materials and to protect the cap. If excavation is necessary in wetland areas, actions would be taken to avoid impacts to such wetlands, minimize wetlands destruction, and preserve and enhance the value of the wetlands as required by 40 C.F.R. Part 6, Appendix A.

Anomalies identified during the magnetometer survey conducted in the Remedial Investigation phase would be investigated and all buried intact and crushed drums would be excavated. The drums and surrounding soils would be disposed of offsite. Soils would be tested for hazardous characteristics and handled in accordance with RCRA, including Land Disposal Restriction treatment requirements. EPA suspects that a portion of the buried drums are located beneath the garage of the onsite residence. Should EPA confirm that anomalies exist beneath the garage, partial demolition of the garage may be necessary.

The groundwater treatment facility would be augmented by adding a metals precipitation unit as well as a vapor-phase carbon unit for off-gas treatment. The metals precipitation unit would

remove the metal contaminants from the groundwater while the VOCs continue to be removed by the air stripping unit. These additions would satisfy Clean Water Act effluent discharge requirements and Clean Air Act air emission limits for organic and inorganic pollutants. The treated groundwater would be discharged to the wetland area adjacent to the treatment building.

Carbon filters previously placed on affected residential wells would continue to be maintained and the well water would continue to be monitored to be sure contaminated groundwater from the Site is not reaching the wells. MCLs for the relevant contaminants would be met at residential wells. Institutional controls would be implemented to protect the integrity of the cap and the existing groundwater treatment system. An operation and maintenance program to maintain the groundwater treatment system, cap, and GAC filters installed at impacted residences would be implemented. Since hazardous substances would be left onsite, a review of Site conditions would be required no less often than every five years pursuant to Section 121(c) of CERCLA, 42 U.S.C. § 9621(c).

**Alternative 4:            Soil Excavation and Stabilization/Solidification; Excavation and Offsite Disposal of Buried Drums; Groundwater Extraction, Metals Precipitation, and UV Oxidation; Institutional Controls and Monitoring; and Residential Water Treatment**

**Capital Cost                                \$10,770,000**  
**Total Present Worth Cost    \$21,580,000**  
**Operation & Maintenance (O&M)(30 yr) \$700,000/yr**

This alternative combines stabilization/solidification (S/S) of contaminated soils, offsite disposal of buried drums, groundwater extraction, metals precipitation, and UV Oxidation with the institutional controls and monitoring and residential water treatment described in Alternative 2.

In situ S/S of the contaminated overburden soil from the top of the test pit areas to the top of the bedrock would occur. Approximately 32,700 cubic yards (cy) of soil would be stabilized using equipment capable of injecting stabilization reagents and mixing the soil below the ground surface. Ex situ S/S of contaminated subsurface and surface soil from the wetlands, uplands, and the farmhouse area would also occur. Contaminated soils (approximate locations shown of Figure 5) would be excavated down to a level where all contaminants of potential concern (COPCs) are below the risk-based concentrations (RBCs) identified in the risk assessment for the Boarhead Farms Site. These soils would be tested to determine whether they exhibit hazardous characteristics in accordance with RCRA, treated as required, moved to a central area, and stabilized ex situ using a transportable stabilization plant. Before stabilization, soil would be stockpiled on a liner to prevent contamination from leaching into the underlying stabilized soil. Stabilized soil would be placed in the test pit area and covered with 18 inches of clean soil to provide a buffer. Clean soil would be used to cover the stabilized soil as well as to backfill the

excavated areas. If excavation is necessary in wetland areas, actions would be taken to avoid adverse impacts to such wetlands, minimize wetlands destruction, and preserve and enhance the value of the wetlands to the extent required by 40 C.F.R. Part 6, Appendix A.

The existing groundwater treatment facility would be modified by replacing the current air stripper with a UV oxidation unit and adding a metals precipitation unit. The remaining buried drums would be excavated and disposed of offsite as in the alternatives above.

Institutional controls would be added to protect the stabilized materials from being disturbed. Such controls will prohibit excavation and regrading in the areas where stabilization has occurred. An O&M program to maintain the groundwater treatment system and residential GAC filters would be implemented. Since hazardous substances would be left onsite, a review of Site conditions would be required no less often than every five years pursuant to Section 121(c) of CERCLA, 42 U.S.C. § 9621(c).

**Alternative 5:           Excavation of Soil and Placement in Onsite Landfill; Excavation and Offsite Disposal of Buried Drums; Groundwater Extraction, Metals Precipitation, and Air Stripping; Institutional Controls and Monitoring; and Residential Water Treatment**

<b>Capital Cost</b>	<b>\$6,890,000</b>
<b>Total Present Worth Cost</b>	<b>\$13,090,000</b>
<b>Operation &amp; Maintenance (O&amp;M)(30 yr)</b>	<b>\$400,000/yr</b>

This alternative combines the construction of an onsite landfill with the drum excavation and offsite disposal, groundwater extraction, metals precipitation, air stripping, institutional controls and monitoring, and residential well treatment described in the above alternatives.

The newly constructed landfill would be positioned in the central area. Outlying contaminated soils (see Figure 5 for an approximation of location and extent; the actual extent of excavation would be determined during remedial design) as well as the soils in the central area would be excavated down to levels where all contaminants of potential concern (COPCs) are below the risk-based concentrations (RBCs) identified in the risk assessment for the Boarhead Farms Site. These soils would be tested to determine whether they exhibit hazardous characteristics in accordance with RCRA, treated as required, and placed into the landfill. The landfill lining system would include a leachate collection system, double lining, and a leak detection system. Approximately 65,400 cubic yards (cy) of capacity would be required. Leachate collected from the cell would be treated at the onsite groundwater treatment plant. The landfill would be capped with a multilayer RCRA cap and a security fence installed. If excavation is necessary in wetland areas, actions would be taken to avoid adverse impacts to such wetlands, minimize wetlands

destruction, and preserve and enhance the value of the wetlands to the extent required by 40 C.F.R. Part 6, Appendix A.

Institutional controls would be implemented to protect the integrity of the landfill and the groundwater treatment system. In addition, a fence would be constructed around the landfill to ensure protection from trespassers. An O&M program to maintain the landfill, groundwater treatment facility, residential GAC filters, and fence would be implemented. Since hazardous substances would be left onsite, a review of Site conditions would be required no less often than every five years pursuant to Section 121 (c) CERCLA, 42 U.S.C. § 9621(c).

**Alternative 6:      Soil Aeration and Treatment of VOC Hot Spots; Excavation and Offsite Disposal of Buried Drums; Groundwater Extraction, Metals Precipitation, and Air Stripping; Institutional Controls and Monitoring; and Residential Water Treatment**

<b>Capital Cost</b>	<b>\$7,180,100</b>	
<b>Total Present Worth Cost</b>	<b>\$13,157,000</b>	
<b>Operation &amp; Maintenance (O&amp; M)(30 yr)</b>		<b>\$463,900/yr</b>

This alternative uses aeration of soil hot spots contaminated with high concentrations of VOCs in combination with the offsite disposal of buried drums, groundwater extraction, metals precipitation, air stripping, institutional controls and monitoring, and residential water treatment as described in the above alternatives.

The soils from two hot spot areas identified during the RI/FS would be collected and mechanically aerated in a temporary containment building constructed onsite to remove the VOC contaminants. The building would be equipped with dust and carbon filtration units for air treatment. The off-gas treatment would be designed to meet air emissions ARARs. The water that refills the excavated TCE area would be pumped to the existing treatment system or air sparged. The clean soils would be used as fill for the excavated areas. Since excavation would be necessary in wetland areas, actions would be taken to avoid adverse impacts to such wetlands, minimize wetlands destruction, and preserve and enhance the value of the wetlands to the extent required by 40 C.F.R. Part 6, Appendix A.

Carbon filters previously placed on affected residential wells would continue to be maintained and the residential well water would continue to be monitored to be sure contaminated groundwater from the Site is not reaching the wells. An O&M program to maintain the soil aeration/treatment system, the groundwater treatment facility, and residential GAC filters would be implemented. Since hazardous substances would be left onsite, a review of Site conditions would be required no less often than every five years pursuant to Section 121 (c) of CERCLA, 42 U.S.C. § 9621(c).

## **IX. COMPARATIVE EVALUATION OF ALTERNATIVES**

Each of the remedial alternatives summarized in this ROD has been evaluated against the nine evaluation criteria set forth in the NCP (see 40 C.F.R. Section 300.430(e)(9)). These nine criteria can be categorized into three groups -- threshold criteria, primary balancing criteria, and modifying criteria. A description of the evaluation criteria is presented below:

### **Threshold Criteria:**

1. Overall Protection of Human Health and the Environment addresses whether a remedy provides adequate protection and describes how risks are eliminated, reduced, or controlled.
2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) addresses whether a remedy will meet all of the applicable, or relevant and appropriate requirements of federal environmental laws, as well as state environmental or facility siting laws.

### **Primary Balancing Criteria:**

3. Long-term Effectiveness and Permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time once clean up levels are achieved.
4. Reduction of Toxicity, Mobility, or Volume through Treatment addresses the degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume of contaminants.
5. Short-term Effectiveness addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during implementation of the alternative.
6. Implementability addresses the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement that remedy.
7. Cost refers to an evaluation of several categories of costs associated with a particular alternative. The cost categories include capital costs, including direct and indirect costs; annual operation and maintenance costs; and net present value of capital and O&M costs.

### Modifying Criteria:

8. State Acceptance indicates whether the State concurs with, opposes, or has no comment on EPA's preferred alternative.
9. Community Acceptance assesses public reaction -- evidenced by public comment on the Administrative Record file and the Proposed Plan -- to each of the alternatives considered for the Site.

#### 1. Overall Protection of Human Health and the Environment

A primary requirement of CERCLA is that the selected remedial alternative be protective of human health and the environment. A remedy is protective if it reduces current and potential risks to acceptable levels under the established risk range posed by each exposure pathway at the Site.

Alternative 1 would not protect human health and the environment as unacceptably high risks discussed in Section VII (Summary of Site Risks) would remain at the Site. Accordingly, this alternative will not be further analyzed in this ROD.

Although VOCs in the groundwater are treated in Alternative 2, system capacity is likely inadequate, air emissions are generated, inorganics are not reduced, and contaminants will migrate offsite. In addition, under Alternative 2 no soil contamination would be addressed and the contaminants in the soil hot spots would continue to leach into the groundwater. MCLs for the residential water supply would be met. Alternative 2 as a whole would not adequately protect human health and the environment since unacceptably high risks discussed in Section VII (Summary of Site Risks) would remain at the Site. Accordingly, this alternative will not be further analyzed in this ROD.

Alternatives 3, 4, 5, and 6 are all protective of human health and the environment. All four alternatives provide for an upgrade of the existing groundwater treatment facility with the addition of a metals precipitation unit and methods for further treatment of VOCs. Each of the four alternatives also reduces the risk of exposure to contaminated soils. Under Alternative 3 the wastes remain onsite, but installation of the cap will minimize infiltration and leaching through the contaminated soil above the groundwater table. Under Alternative 4, soil stabilization and solidification would occur, preventing further leaching altogether. Alternative 5 would protect human health and the environment by containing the contaminated soils and hot spots in an onsite landfill. The landfill would be constructed in a manner that would minimize infiltration and leaching. Access to contaminated soils would thus be significantly reduced once the soils were placed in the landfill. Alternative 6 is protective through largely eliminating organic contaminants from the hot spot areas, in turn reducing the possibility of the organics leaching

into the groundwater. With the inclusion of institutional controls, monitoring, and continued excavation and removal of buried drums, each of the Alternatives 3, 4, 5, and 6 would reduce the possibility of further exposure to contaminated soils and further consumption of contaminated groundwater.

## 2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

Any cleanup alternative considered by EPA must comply with all applicable or relevant and appropriate federal and state environmental requirements. Applicable requirements are those substantive environmental standards, requirements, criteria, or limitations promulgated under federal or state law that are legally applicable to the remedial action to be implemented at the Site. Relevant and appropriate requirements, while not being directly applicable, address problems or situations sufficiently similar to those encountered at the Site that their use is well-suited to the particular Site.

### Chemical-Specific ARARs

Alternatives 3, 4, 5, and 6 would satisfy treatment effluent discharge requirements and air emission limits for organic and inorganic pollutants. Alternatives 2 through 6 would also meet MCL levels at residential wells. Alternative 1 would not meet these requirements.

### Action-Specific ARARs

Alternatives 3 and 5 would meet the substantive requirements of any required Resource Conservation and Recovery Act (RCRA) treatment, storage and disposal (TSD) ARARS such as design, operation, closure, and post-closure of a RCRA landfill.

Alternatives 3 and 4 would meet RCRA hazardous waste ARARs triggered by excavation of contaminated soils including storage time limits, manifesting, and transporting requirements. Alternatives 3 and 5 may require that the Site be designated a corrective action management unit (CAMU) to avoid invoking RCRA's land disposal restrictions (LDRs).

Treatment of inorganics in onsite groundwater (Alternatives 3 through 6) and treatment of off-gas (Alternatives 3, 5, and 6) will require offsite disposal, proper manifesting, and tracking to ensure that waste arrives at a permitted facility.

### Location-Specific ARARs

If wetlands are disturbed in Alternatives 3, 4, 5, and 6 actions will be taken to avoid adverse impacts to such wetlands, minimize wetlands destruction, and preserve and enhance the value of the wetlands, to the extent required by 40 CFR Part 6, Appendix A.

### 3. Long-Term Effectiveness and Permanence

#### Magnitude of Residual Risk

Alternative 4 would provide more expedient control of residual risk since the soil contamination would be immediately stabilized to minimize leaching. Alternative 3, which provides a cap over the central area, would allow contaminants underneath the cap to desorb into the groundwater and leave residual contamination in the soil above the water table. Alternative 5 would reduce the risk of exposure to residual contaminants since such contaminants would be encapsulated in the onsite landfill. Alternative 6 would reduce residual risk in the hot spot areas since the soil would be removed and treated, thus minimizing leaching. O&M of the landfill and groundwater treatment system and institutional controls provided for in Alternatives 3, 4, 5, and 6 would reduce the risk of migration and risk of exposure from residual contamination.

#### Adequacy and Reliability of Controls

Alternatives 3, 4, 5, and 6 offer equally reliable groundwater treatment processes capable of removing contaminants from the groundwater intercepted by the downgradient trench. For contaminated soils, Alternative 3 can reliably minimize surface water infiltration and resulting contaminant desorption. Alternatives 4 and 5, using soil solidification/stabilization and landfilling can reliably prevent leaching effects and provide groundwater protection. Although stabilization technology works well with certain types of wastes, particularly heavy metals, recent literature on the effectiveness of stabilization on VOC-contaminated soils shows that this approach is not always effective and VOCs continue to leach from the stabilized areas. Therefore, while stabilization has been shown to be protective with respect to metals-contaminated soils, EPA concludes that this technology may not be as protective of the community with respect to the VOC contamination. Alternative 6, soil aeration, can reliably remove VOCs from the hot spot areas.

### 4. Reduction of Toxicity, Mobility, or Volume through Treatment

Toxicity and volume reduction are not fully achieved by capping in Alternative 3 since the contaminants in the soil would not be fully isolated. The contaminants would still leach into the groundwater over time until reaching the trench system or extractions wells. A slight reduction in mobility would eventually occur, however, since downward infiltration of groundwater would decrease. Alternative 4 generates less waste through organic treatment than Alternatives 3, 5, and 6 since carbon filters are not used in the treatment system. Alternative 6 would reduce the volume and toxicity of organic contaminants in select hot spots only.

Alternatives 3 through 6 would aid in reducing toxicity if the existing onsite treatment facility is maintained properly.



## 5. Short-Term Effectiveness

Alternatives 3, 4, 5, and 6 are equally effective in the short-term, but present various risks of exposure during construction since contaminated soil is excavated.

## 6. Implementability

Each of the alternatives is technically implementable. Alternatives 3, 4, 5, and 6 require treatability studies and/or specialty contractors for items such as capping, stabilization, and soil aeration.

Since UV oxidation in Alternative 4 does not generate air emissions, installation of carbon filter units and associated maintenance is not required. Alternative 4 requires more effort to implement than the other alternatives due to the volume of soil that is excavated, treated chemically, and relocated. Design, construction, and operation of the landfill (Alternative 5) requires a high level of effort to implement and requires long-term O&M.

## 7. Cost

Evaluation of the costs of each alternative generally includes calculation of direct and indirect capital costs and the annual operation and maintenance (O&M) costs, both calculated on a present worth basis. The total present worth cost of all Alternatives has been calculated for comparative purposes and is presented below.

Alternative	Total Present Worth Cost
1	\$0
2	\$3,000,000
3	\$11,690,000
4	\$21,580,000
5	\$13,090,000
6	\$13,157,000

Direct capital costs include costs of construction, equipment, building and services, and waste disposal. Indirect capital costs include engineering expenses, start-up and shutdown, and contingency allowances. Annual O&M costs include labor and material; chemicals, energy, and fuel; administrative costs and purchased services; monitoring costs; cost for periodic site review

(every five years); and insurance, taxes, and license costs. For cost estimation purposes, a period of 30 years has been used for O&M. In reality, maintenance of a multilayer cap on a landfill would be expected to continue beyond this period. Similarly, the actual duration of operation for the groundwater extraction and treatment system would depend on the system's ability to successfully limit offsite migration of Site-related contaminants.

#### 8. State Acceptance

The Commonwealth of Pennsylvania has concurred with the selected remedy.

#### 9. Community Acceptance

A public meeting on the Proposed Plan was held on January 14, 1998 at the Palisades High School, Kintnersville, Pennsylvania. Comments received orally at the public meeting and in writing during the comment period are presented and addressed in the Responsiveness Summary, Part III of this ROD.

### **X. SELECTED REMEDY AND PERFORMANCE STANDARDS**

Following consideration of the requirements of CERCLA, a detailed analysis of the alternatives using the nine criteria set forth in the NCP, and careful review of public comments, EPA has selected Alternative 6 for implementation at the Boarhead Farms Site. The following are the key components of the selected remedy:

- A. **Soil Aeration and Treatment of VOC Hot Spots:** Two areas were identified during the FS that contain high levels of VOCs and are outside the reach of the existing collection trench system. The first is located west of the Site residence and south of the Keystone garage. Soils in this area contain high levels of benzene. The area is along a small weed-overgrown road leading from the Keystone garage area toward the Pennsylvania game lands. Soils with benzene levels in excess of 0.5 ppm (the statewide soil-to-groundwater standard for benzene established under Pennsylvania's Land Recycling and Environmental Remediation Standards Act (35 P.S. §§ 6026.101-6026.909) and implementing regulation) shall be excavated from this area such that the benzene concentrations in the bottom and side walls of the excavation do not exceed 0.5 ppm. The second VOC hot spot area is approximately 1/4 mile from the residence along and including a small road leading north from the main site access road. This area contains high levels of TCE. Soils with TCE in excess of 0.4 ppm (EPA's risk-based cleanup level developed in the risk assessment) will be excavated such that TCE concentrations in the bottom and side walls of the excavation do not exceed 0.4 ppm TCE. EPA estimates that there are approximately 2,000 cubic yards (cy) of contaminated soils in the benzene

contaminated area and 10,000 cy in the TCE - contaminated area that will need to be excavated. The wooded wetlands shall be left undisturbed.

Excavated soils shall be relocated to an onsite facility (to be constructed) where the VOCs will be stripped from the soils. Air stripping will occur via mechanical aeration down to levels of 0.5 ppm for benzene (the statewide soil-to-groundwater standard for benzene established under Pennsylvania's Land Recycling and Environmental Remediation Standards Act (35 P.S. §§ 6026.101-6026.909) and implementing regulation) and 0.4 ppm for TCE (EPA's risk-based cleanup level developed in the risk assessment). Treatment will involve construction of a temporary onsite treatment building equipped with carbon filters to ensure that air quality criteria are maintained. Clean soils will be returned to the areas of excavation.

- B. **Excavation and Offsite Disposal of Buried Drums:** All metal anomaly areas identified in the RI shall be excavated down to the bedrock in order to find buried drums. A drum is any container which could contain five or more gallons. Upon drum encounter the buried drum and all soils in intimate contact with the drum shall be excavated and overpacked for offsite disposal. Soils in intimate contact with drums are soils within eighteen inches of the surfaces of such drums or, where visible contamination is present, all visibly stained soils. Care will be taken not to allow drum contents to spill on to the ground. If spillage occurs, the spillage area along with 18 inches of soil around the spill area will be excavated and overpacked for offsite disposal. Drum contents and related excavated soils will be characterized in accordance with RCRA characterization protocols, treated as required, and disposed of to reduce the potential for continued migration of contaminants to the soil and groundwater as well as to reduce the risk of exposure.
- C. **Groundwater Extraction, Metals Precipitation, and Air Stripping:** Groundwater will be collected and extracted using the existing interceptor trench and extraction wells and treated using air stripping (for VOCs) and metal precipitation (for metals) systems. Treatment of extracted groundwater shall continue until MCLs or the non-zero Maximum Contaminant Level Goals (MCLGs) for groundwater are met at the interceptor trench for eight (8) consecutive quarters (see detailed requirements #6, below). Any surface water discharge will comply with the substantive requirements of the Clean Water Act NPDES regulations (40 C.F.R. §§ 122.41-122.50), the Pennsylvania NPDES regulations (25 Pa Code § 92.31), the Pennsylvania Wastewater Treatment regulations (25 Pa Code §§ 95.1-95.3), and the Pennsylvania Water Quality Standards (25 Pa Code §§ 93.1-93.9). Air emissions from this system must comply with the requirements of the Clean Air Act.
- D. **Institutional Controls and Monitoring:** Institutional controls to protect the integrity of the interceptor trench, groundwater treatment system, soil aeration treatment area, and

phytoremediation area will be implemented and will remain in effect as long as is necessary to achieve the Performance Standards. Institutional controls will also be implemented to protect the previously installed soil cover (the areal extent of which is between and among the test pits approximated in Figure 4) and will remain in effect as long as necessary to prevent exposure to contaminated subsoils. Site wells and selected residential drinking water wells will be monitored to evaluate the effectiveness of the remedy as provided in paragraph 8, below.

- E. **Installation of Additional Monitoring Wells:** Additional monitoring wells will be installed to monitor the migration of contaminants in the shallow and intermediate groundwater zones, as well as to monitor the effectiveness of the remedial action. A minimum of two additional wells shall be installed along Lonely Cottage Road, with one across from the Sportsman's Club. The total number and location of other additional monitoring wells will be determined during remedial design.
- F. **Residential Water Treatment:** The granular activated carbon (GAC) filters that were installed on affected residential water wells in the surrounding area to prevent exposure to contaminated groundwater from the Site shall be maintained. GAC units will be replaced as needed based on their performance as determined by the long-term monitoring program to ensure the health and safety of the residents. Used filters shall be disposed of in accordance with State and Federal laws. Monitoring of the affected residential wells will occur until EPA determines that the Performance Standard for each contaminant of concern has been achieved for all residences with wells equipped with GAC filters installed during the removal action; the wells shall be sampled semiannually for three years after the Performance Standard is met for all affected wells, and if contaminants remain at or below the Performance Standards, the GAC filters shall be removed and properly disposed.
- G. **Phytoremediation:** A treatability study will be performed to determine whether or not phytoremediation will aid in uptake of the contaminants at the Site. The specific type and location of the plants used in the process will be determined in the design of the treatability study. In addition, during the study the parameters to identify whether or not the phytoremediation process is removing enough contaminants from the soil and groundwater to be of use to the remediation process will be determined. EPA will determine, based on the results of the treatability study, whether phytoremediation will be implemented at the Site. The plants will be used to augment the efficiency of the interceptor treatment system on a long-term basis. Plants will be maintained and replaced as needed. The specific type and placement of these plants will be determined in the treatability study.

Further detailed requirements and Performance Standards associated with the selected remedy are presented below.

1. Excavated soils, drums, spent filter media and spent filters shall be tested to determine the presence of RCRA characteristic wastes. All RCRA characteristic wastes shall be handled in accordance with the substantive requirements of 25 Pa. Code Chapter 262 Subchapters A (relating to hazardous waste determination and identification numbers); B (relating to manifesting requirements for offsite shipments of hazardous wastes); and C (relating to pretransport requirements); 25 Pa. Code Chapter 263 (relating to transporters of hazardous wastes); and with respect to the operations at the Site generally, with the substantive requirements of 25 Pa. Code Chapter 264, Subchapters B-D, I (in the event that hazardous waste generated as part of the remedy is managed in containers); 25 Pa. Code Chapter 264, Subchapter J (in the event that hazardous waste is managed, treated, or stored in tanks), and 40 C.F.R. Part 268, Subpart C and Subpart E (regarding prohibitions on land disposal and prohibitions on storage of hazardous waste).
2. All areas impacted by the construction activities during remedy implementation shall be graded, restored and revegetated to the extent practicable.
3. Wastewater generated during decontamination activities shall be properly managed in accordance with State and Federal Laws.
4. Fugitive dust emissions generated during remedial activities will be controlled in order to comply with fugitive dust regulations in the federally-approved State Implementation Plan (SIP) for the Commonwealth of Pennsylvania, 25 Pa. Code §§ 123.1 - 123.2 and the National Ambient Air Quality Standards for Particulate Matter in 40 C.F.R. § 50.6 and Pa. Code §§ 131.2 and 131.3.
5. Drum Excavation and Removal - All areas identified in the remedial investigation where buried metal anomalies (such as buried drums) were detected will be excavated and investigated. All drums found containing any material will be overpacked, staged, RCRA categorized, treated (if required by RCRA) and shipped offsite for disposal. Soils in intimate contact with these drums will be excavated, treated (if required by RCRA), and disposed. Soils in intimate contact with drums are soils within eighteen inches of the surfaces of such drums or, where visible contamination is present, all visibly stained soils. Management of drum waste from these excavated areas shall comply with the requirements of 25 Pa. Code Chapter 262 Subchapters A (relating to hazardous waste determination and identification numbers); B (relating to manifesting requirements for offsite shipments of hazardous wastes); and C (relating to pretransport requirements); 25 Pa. Code Chapter 263 (relating to transporters of hazardous wastes); and with respect to the operations at the Site generally, with the substantive requirements of 25 Pa. Code

Chapter 264, Subchapters B-D, I (in the event that hazardous waste generated as part of the remedy is managed in containers); 25 Pa. Code Chapter 264, Subchapter J (in the event that hazardous waste is managed, treated or stored in tanks); and 40 C.F.R. Part 268 Subpart C, Section 268.30, and Subpart E (regarding prohibitions on land disposal and prohibitions on storage of hazardous waste).

6. Groundwater Treatment - A) The groundwater at the interceptor trench shall be extracted and treated in the onsite treatment facility until the MCLs, health advisory levels, or risk-based ingestion or inhalation numeric values set forth under Pennsylvania Act 2 standards (35 P.S. §§ 6026.101 - 6026.909) for all contaminants of concern are achieved for eight (8) consecutive quarters of sampling. The Performance Standards for the contaminants in the groundwater are listed below:

<u>Contaminant</u>	<u>MCL(ug/l)</u>	<u>Health Advisory</u>	<u>Inhalation</u>
Arsenic	50		
Beryllium	4		
Cadmium	5		
Chromium (Total)	100		
Zinc		2,000	
Benzene	5		
Trichloroethene (TCE)	5		
1,1-Dichloroethene (1,1-DCE)	7		
Xylenes	10,000		
Lead	5		
Nickel		100	
1,1- Dichloroethane (1,1-DCA)			27
Cis - 1,2-Dichloroethene	70		
Ethylbenzene	700		
Tetrachloroethene(PCE)	5		
1,1,1-Trichloroethane	200		

B) Recovered groundwater shall be treated to remove VOCs and metals and discharged in accordance with the substantive requirements of the Clean Water Act NPDES discharge regulations (40 C.F.R. §§ 122.41-122.50), the Pennsylvania NPDES regulations (25 Pa Code § 92.31), the Pennsylvania Wastewater Treatment regulations (25 Pa Code §§ 95.1-95.3), and the Pennsylvania Water Quality Standards (25 Pa Code §§ 93.1-93.9). The treatment system shall reduce the contaminants in the extracted groundwater, unattended, on a continuous, 24-hour-per-day basis. The final pumping rate of the extraction wells shall be determined during remedial design. Final design criteria

for the air stripper and metals precipitation treatment systems will be determined in the Remedial Design phase.

C) Any VOC emissions from treatment of groundwater, including air stripping and/or air sparging, will be in accordance with the Pennsylvania air pollution regulations outlined in 25 Pa. Code §§ 121.1 - 121.3, 121.7, 123.1, 123.2, 123.31, 123.41, 127.1, 127.11, 127.12, and 131.1 - 131.4. 25 Pa. Code § 127.12 requires all new air emission sources to achieve minimum attainable emissions using the best available technology (BAT). In addition, the PADEP air permitting requirements for remediation projects require all air stripping and vapor extraction units to include emission control equipment. Federal Clean Air Act requirements, 42 U.S.C. §§ 7401 *et seq.*, are applicable and must be met for the discharge of contaminants to the air. Air permitting and emissions requirements are outlined in 40 C.F.R. §§ 264.1030 - 264.1034 (Air Emissions Standards for Process Vents), and 40 C.F.R. §§ 264.1050 - 264.1063 (Air Emissions Standards for Equipment Leaks). OSWER Directive #9355.0-28, Control of Air Emissions from Superfund Air Strippers at Superfund Ground Water Sites, is a "to be considered" (TBC) requirement.

D) Management of waste from the operation of the treatment system (i.e. spent carbon units, flocculates) shall comply with the requirements of 25 Pa. Code Chapter 262 Subchapters A (relating to hazardous waste determination and identification numbers); B (relating to manifesting requirements for offsite shipments of hazardous wastes); and C (relating to pretransport requirements); 25 Pa. Code Chapter 263 (relating to transporters of hazardous wastes); and with respect to the operations at the Site generally, with the substantive requirements of 25 Pa. Code Chapter 264, Subchapters B-D, I (in the event that hazardous waste generated as part of the remedy is managed in containers); 25 Pa. Code Chapter 264, Subchapter J (in the event that hazardous waste is managed, treated or stored in tanks); and 40 C.F.R. Part 268 Subchapter C, Section 268.30, and Subchapter E (regarding prohibitions on land disposal and prohibitions on storage of hazardous waste).

7. The extraction and treatment system shall avoid, minimize, and mitigate impacts on the area wetlands in compliance with Executive Order No. 11990 and 40 C.F.R. Part 6, Appendix A (regarding avoidance, minimization, and mitigation of impacts on wetlands).
8. Maintenance and Monitoring

A) The soil aeration equipment, groundwater extraction and treatment system, residential water treatment systems, phytoremediation areas, Site monitoring wells, previously installed soil cover, and all other remedial action components shall be operated and maintained in accordance with an Operation and Maintenance plan to be developed for this remedial action. The Operation and Maintenance plan shall ensure that all remedial action components operate within design specifications and are maintained in a manner that will achieve the Performance Standards. The Operation and Maintenance plan shall be updated from time-to-time as may be necessary to address additions and changes to the remedial action components (e.g., following metals-treatment upgrades to the water treatment plant).

B) A long-term groundwater monitoring program shall be implemented to evaluate the effectiveness of the interceptor trench, treatment system, and other remedial action components in reducing contamination in the groundwater to achieve the Performance Standards. The long-term groundwater monitoring program will provide for the sampling and analysis of groundwater from Site monitoring and selected residential drinking wells, the maintenance of Site monitoring wells, and for, among other things, the following:

(i) The installation of additional monitoring wells may be required to monitor the migration of contaminants in the shallow and intermediate groundwater zones. Numbers and locations of these monitoring wells shall be determined (as needed) by EPA during the remedial design, in consultation with PADEP.

(ii) The monitoring and residential drinking water wells shall be sampled at least three times a year for the first three years. Based on the findings of the first three years of sampling, the appropriate sampling frequency for subsequent years will be determined by EPA, in consultation with PADEP.

(iii) The influent and effluent from the treatment facility shall be sampled a minimum of once per month and analyzed for each contaminant for which a Performance Standard has been provided in Paragraph 6A.

(iv) Sampling from and operation/maintenance of the monitoring wells and groundwater extraction/treatment system shall continue until such time when EPA, in consultation with PADEP, determines that groundwater treatment is no longer necessary as set forth herein.

(a) EPA, in consultation with PADEP, shall determine whether the Performance Standard for each contaminant for which a Performance Standard has been provided in Paragraph 6A, above, has been achieved throughout the entire area of groundwater contamination. Following any such determination, the monitoring wells shall continue be sampled for eight (8) consecutive quarters (the "Confirmation Period").

(b) If any Paragraph 6A contaminant is detected in groundwater at a concentration above the Performance Standard at any time during the Confirmation Period, the Confirmation Period shall end and sampling and operation/maintenance of the monitoring wells and extraction/treatment system shall continue. EPA, in consultation with PADEP, shall again determine whether the Performance Standard for each contaminant for which a Performance Standard has been provided in Paragraph 6A, above,



has been achieved throughout the entire area of groundwater contamination as described in Paragraph (iv)(a), above.

(c) If EPA, in consultation with PADEP, determines at the close of the Confirmation Period that no Paragraph 6A contaminant has been detected in groundwater at a concentration above the Performance Standard at any time during the Confirmation Period, the extraction/treatment system shall be shut down. Annual monitoring of the groundwater shall continue for five years after the groundwater extraction/treatment system is shutdown. If, subsequent to an extraction/treatment system shutdown, annual monitoring shows that any Paragraph 6A contaminant is detected in groundwater at a concentration above the Performance Standard, the extraction/treatment system shall be restarted and operated/maintained. EPA, in consultation with PADEP, shall again determine whether the Performance Standard for each contaminant for which a Performance Standard has been provided in Paragraph 6A, above, has been achieved throughout the entire area of groundwater contamination as described in Paragraph (iv)(a), above.

(d) The extraction/treatment and monitoring system may be modified, as warranted by performance data during operation, to achieve Performance Standards. These modifications may include alternate pumping of extraction well(s) and/or the addition or elimination of certain extraction wells.

(v) Existing pumping and/or monitoring wells which EPA determines during long-term monitoring to serve no useful purpose shall be properly plugged and abandoned consistent with PADEP's Public Water Supply Manual, Part II, Section 3.3.5.11. Wells which EPA determines are necessary for use during the long-term monitoring program will not be plugged.

C) Statutory reviews under Section 121(c) of CERCLA shall be conducted as long as hazardous substances, pollutants, or contaminants remain onsite within the meaning of that section. Such reviews shall be conducted in accordance with "Structure and Components of Five-Year Reviews" (OSWER Directive 9355.7-02, May 23, 1991).

9. Institutional Controls - Institutional controls shall be implemented to protect the integrity of the interceptor trench, groundwater treatment system, soil aeration treatment area, and phytoremediation area during implementation of the remedial action and operation and maintenance. At a minimum, these controls shall ensure that no construction, excavation, or regrading takes place in these areas except as approved by EPA. Institutional controls will also be implemented to protect the previously installed soil cover (the areal extent of

which is between and among the test pits approximated in Figure 4) and will remain in effect as long as necessary to prevent exposure to contaminated subsoils.

10. Structural stability of open excavations shall be maintained with temporary shoring or engineering measures as appropriate. Excavation will begin using a backhoe, and the sides of the excavation area shall be cut back to a minimum 2 to 1 slope to prevent side wall failure. EPA may approve alternative excavation techniques if such techniques ensure the same level of Site safety. Air monitoring shall be conducted during excavations to ensure safety of Site workers and residents living in the vicinity of the Site.
11. Erosion and sediment (E&S) controls and temporary covers will be installed to protect exposed soil from the effects of weather consistent with PADEP's Bureau of Soil and Water Conservation Erosion and Sediment Pollution Control Manual and the Bucks County Soils Conservation policy. Erosion potential shall be minimized. Further controls in the form of Site grading to improve land grades, cover soils, vegetation, and drainage channels to reduce erosion potential from surface runoff may be required to minimize erosion. Contaminated soils shall be prevented from being washed into onsite surface water and adjacent uncontaminated and uncontrolled wetland areas during remedial action implementation. The extent of erosion control necessary will be determined by EPA, in consultation with the PADEP, during the remedial design phase.
12. Post-excavation sampling will be performed after the excavations are completed. For the benzene contaminated area, post-excavation samples will be obtained from the base and the sidewalls of the excavation to ensure that contamination is not present above the soil cleanup Performance Standards specified in Section X, part A. Excavation in the TCE area will extend to the natural boundary of the surrounding wooded wetland so as to not impact the natural remediation created by this resource. The location of the post-excavation samples will be selected based on visual observation of lithology and screening for VOCs using an appropriate organic vapor detector. The samples will be analyzed for VOCs.
13. For all excavation areas other than the TCE area, the excavation will be backfilled using clean soil. Clean borrow material will be brought in to restore the excavation to proximate original grade. Backfilling will be performed, and the material will be compacted to minimize the potential for subsidence. The excavation area shall be covered with a layer of cover soil and revegetated with native plant material until a viable cover is established. The contents of "Office of the Federal Executive; Guidance for Presidential Memorandum on Environmentally and Economically Beneficial Landscape Practices on Federal Landscaped Grounds," 60 Fed. Reg. 40837 (August 10, 1995) shall be considered in implementing any landscaping at the Site.

14. With respect to the benzene-contaminated area, if benzene (or any other VOC) is detected in the post-excavation samples at levels above any of the soil cleanup Performance Standards, additional soil will be removed from the excavation area and new samples obtained and analyzed. Excavation and sampling activities will continue until the results indicate that the soils do not contain contaminants of concern above any of the Performance Standards.
15. Excavated soils, drums, and other materials shall be tested to determine the presence of RCRA characteristic wastes. All RCRA characteristic wastes shall be handled in accordance with Pa. Code §§ 262.11 - 262.13 (relating to hazardous waste determination and identification numbers), 25 Pa. Code § 262.34 (relating to pretransport requirements); 25 Pa. Code Chapter 263 (relating to transporters of hazardous wastes); and with respect to the operations at the Site generally, with the substantive requirements of 25 Pa. Code Chapter 264, Subchapters B-D, I (in the event that hazardous waste is generated as part of the remedy).

## **XI. STATUTORY DETERMINATIONS**

The following sections discuss how the selected remedy for the Boarhead Farms Site meets the statutory requirements contained in CERCLA.

### **A. Overall Protection of Human Health and the Environment**

The Baseline Risk Assessment (BLRA) conducted at the Boarhead Farms Site describes the risks to human health resulting from contamination at the Site. Onsite residents consuming groundwater from the onsite residential wells are at the highest risk. In addition, risks above the Hazard Index of 1 are present for offsite residents downgradient from the Site consuming groundwater from residential wells, onsite workers consuming contaminated groundwater, recreational Site users in the wetlands areas, and recreational offsite users consuming fish from the culverts and creeks running from the Site. Implementation of Alternative 6 at the Boarhead Farms Site will eliminate all unacceptable human health and ecological risks identified in the BLRA.

Soil aeration and treatment of TCE and benzene soil hot spots called for in the selected remedy will reduce the risk of exposure to high levels of contamination in the hot spot areas. In addition, soil aeration will eliminate the possibility of TCE and benzene leaching into the groundwater from the hot spot soils.

Excavation and offsite disposal of the remaining buried drums and associated soils will reduce to acceptable levels the risk of the contaminants associated with the drums leaching into the groundwater or further contaminating the surrounding soils. Filling in these excavated areas will reduce the potential of future exposure to contaminated soils through ingestion and direct contact.

Groundwater extraction, metals precipitation, and air stripping through upgrading the existing groundwater treatment facility will reduce the potential of contaminated groundwater moving offsite. The upgraded system will remove VOC and metals contamination from all groundwater flowing into the interceptor trench and extraction wells, and treated groundwater will be discharged to the adjacent wetland areas. This will reduce the risks of exposure through inhalation, ingestion and dermal contact to offsite residents.

Implementation of the selected remedy will not pose any unacceptable short term risks or cross media impacts to the Site or the community.

B. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

The selected remedy will comply with all applicable or relevant and appropriate chemical-specific, location-specific and action-specific ARARs as discussed above in Section X of this ROD.

C. Cost-Effectiveness

The selected remedy is cost-effective in providing overall protection in proportion to cost, and meets all other requirements of CERCLA. Section 300.430(f)(1)(ii)(D) of the NCP requires EPA to evaluate cost-effectiveness by comparing all the alternatives which meet the threshold criteria - protection of human health and the environment and compliance with ARARs - against three additional balancing criteria: long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; and short-term effectiveness. The selected remedy meets these criteria and provides for overall effectiveness in proportion to its cost.

The combined estimated present worth cost for the selected remedy presented in this Record of decision is \$13,157,000.

D. Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized while providing the best balance among the other evaluation criteria. Of those alternatives evaluated that are protective of human health and the environment and meet ARARs, the selected remedy provides the best balance of tradeoffs in terms of long-term and short-term effectiveness and permanence, cost effectiveness, implementability, reduction in toxicity, mobility, or volume through treatment, State and community acceptance, and preference for treatment as a principal element.

Under the selected remedy, groundwater treatment using air stripping and metals precipitation is more cost effective than UV oxidation. The air stripper unit will achieve the same purpose as UV oxidation, but at a lower cost.

Soil aeration at the TCE and benzene hot spot areas reduces volume, toxicity, and mobility of soil contaminants and reduces both short-term and long-term risks of exposure. Additionally, soil aeration provides long-term effectiveness and permanence. Soil aeration was chosen over other soil remediation techniques since it is more cost effective and removes the source of VOC contamination in the soil hot spot areas. In addition, it eliminates the possibility of further leaching of the TCE and benzene into groundwater in the selected hot spots.

E. Preference for Treatment as a Principal Element

The selected remedy satisfies the preference for treatment in that it employs treatment to address the principal threat posed by conditions at the Site. The interceptor trench and treatment system provide active treatment to hazardous substances entrained in the surficial aquifer and the mechanical aeration and air filtration will further reduce the amount of VOCs being released into the environment. The principal threats of ingestion and inhalation of, and dermal contact with, contaminated groundwater to offsite residents will be eliminated. In addition, the toxic burden to the groundwater will be significantly reduced.

**XII. DOCUMENTATION OF CHANGES FROM PROPOSED PLAN**

The Proposed Plan identifying EPA's preferred alternative for the Site was released for comment on January 5, 1998. During the public comment period, EPA received numerous comments from the public regarding EPA's Proposed Remedy. These comments are presented in detail in Part III of this ROD, the Responsiveness Summary. Although EPA has not made any significant changes with regards to the Proposed Plan, a few actions have been added.

The description of Alternative 1, No Action, as written in the Proposed Plan, has been changed to explain shut down of the groundwater remediation system with no further remediation taking place on the Site. In addition, EPA determined that Alternative 2 is more accurately characterized as "Continued Maintenance and Monitoring of the Existing Groundwater Interceptor Trench, Treatment Facility, and Residential Well GAC Filters; Institutional Controls."

Institutional controls were added to protect the previously installed soil cover (the aeral extent of which is between and among the test pits approximated in Figure 4).

As a result of public comment and further research, EPA added to the selected alternative the performance of a treatability study during Remedial Design to determine if phytoremediation will aid in cleanup in the main areas of the Site. If, based on the results of such treatability studies, EPA determines that phytoremediation will aid in the cleanup of the Site, vegetation that aides in the uptake of metals and VOCs from the groundwater and soil will be planted in a layer of clean soil overlaying the excavation areas. The goal of phytoremediation is for the plant life to reduce the level of contaminants in the groundwater in the shallow system toward the

interceptor trench, and treat the water through biological processes. EPA does not anticipate a large rise in cost from the additional plant and soil cover.

At the request of several community members, the remedy will include a minimum of two new monitoring wells located in the area between the areas of contamination and the downgradient residents. The purpose of these wells will be to provide additional information to both the community and EPA regarding the effectiveness of the selected remedial action. In addition, EPA will continue to sample the residential and monitoring wells both onsite and in the surrounding areas. If the levels of contaminants rise in the perimeter monitoring wells or residential wells, EPA will consider modifications to the remedy.

APPENDIX A - TOXICOLOGICAL PROFILES OF SELECTED SITE CONTAMINANTS





### *1,1-Dichloroethene (1,1-DCE)*

1,1-DCE is used to make certain plastics, such as packaging materials and flexible films like SARAN wrap, and flame-retardant coatings for fiber and carpet backing. It is a clear, colorless liquid and has a mild, sweet smell like chloroform. 1,1-DCE is considered highly volatile and readily migrates to the atmosphere, where it is photo-oxidized by reaction with hydroxyl radicals. It readily volatilizes through the air-filled pores in near-surface soils. Based on a soil sorption coefficient ( $K_{oc}$ ) value of 65, this compound is expected to be only weakly sorbed to soils. This compound is not expected to undergo hydrolysis or microbial degradation in natural systems. In unsaturated near-surface soils, depending on several factors, including percent organic material, about 60 percent of the compound is expected in the gaseous phase, with only 3 percent in the aqueous phase and the remainder absorbed to soil. In deeper soils, 78 percent of the compound is expected to be in the aqueous phase. That portion of the compound that does not volatilize from soil may be expected to be mobile in groundwater.

EPA reports a chronic oral RfD of  $9.0 \times 10^{-3}$  mg/kg-day with the stipulation that the RfD is currently under review (IRIS, 1995). This RfD has an uncertainty factor (UF) of 1000. The confidence in the study, the database, and the RfD is medium. EPA lists the same value for the interim subchronic RfD (HEAST, 1992). No inhalation RfCs are available, however a risk assessment for this compound is under review by an EPA work group (IRIS, 1995).

The oral RfDs were derived from a chronic oral bioassay in which rats were provided drinking water containing either 50, 100, or 200 mg/L 1,1-dichloroethene. The authors calculated intakes to be 7, 10, and 20 mg/kg/day for male rats and 9, 14, and 30 mg/kg/day for female rats (IRIS, 1995). The female rats evidenced hepatic lesions at all exposure levels, while the males only showed a significant effect at 200 mg/L. Therefore, the LOAEL was set at 9 mg/kg-day; a NOAEL could not be determined.

1,1-DCE has been classified by EPA (IRIS, 1995) as a group C (possible human) carcinogen. This classification indicates limited evidence of carcinogenicity in animals with inadequate evidence of human carcinogenicity and is based on the results of tumors observed in one mouse strain following an inhalation exposure to 25 ppm of 1,1-DCE for 5 days/week for 52 weeks (IRIS, 1995). EPA has established an oral CSF of  $0.6 \text{ (mg/kg/day)}^{-1}$  (IRIS, 1995) and an inhalation Carcinogenic Slope Factor (CSF) of  $0.18 \text{ (mg/kg/day)}^{-1}$  (IRIS, 1995). The oral CSF is only valid if the water concentration is below 600 mg/L, and the inhalation CSF is only valid if the air concentration is less than  $200 \text{ mg/m}^3$ .

EPA lists a one-day health advisory of 2 mg/L and a ten-day health advisory of 1 mg/L (Drinking Water Standards and Health Advisories). The ambient water quality criteria for water and fish consumption is  $3.3 \times 10^{-2}$  mg/L and for fish ingestion only is 1.85 mg/L.

EPA (1986) reports an acute concentration of 11,600 mg/L for the dichloroethenes as the LOEC in aquatic systems. 1,1-DCE has a relatively low octanol/water partition coefficient (5.37) and a BCF range from 20 to 30, which indicates that 1,1-DCE may not accumulate significantly in

animals (Lyman et al., 1982). 1,1-DCE is not very toxic to freshwater or saltwater fish species, with acute LC50 values ranging from 80 to 200 mg/L (EPA, 1980).

*cis-1,2-DCE and trans-1,2-DCE*

1,2-DCE exists in two isomeric forms, *cis*-1,2-DCE and *trans*-1,2-DCE, that are colorless, volatile liquids with a slightly acrid odor. 1,2-DCE is prepared commercially by either the direct chlorination of acetylene or by the reduction of 1,1,2,2-TCA with fractional distillation used to separate the two isomers. 1,2-DCE can also be formed as a by-product during the manufacture of other chlorinated compounds. Commercial use is not extensive, but *trans*-1,2-DCE and mixtures of *cis*- and *trans*-1,2-DCE have been used as intermediates in the production of other chlorinated solvents and compounds, as well as low temperature extraction solvents for dyes, perfumes, and lacquers. Both *cis*- and *trans*-1,2-DCE are moderately flammable and react with alkalis to form chloroacetylene gas, which spontaneously ignites in air.

Information on the toxicity of 1,2-DCE in humans and animals is limited. Workers acutely exposed to 1,2-DCE have been reported to suffer from drowsiness, dizziness, nausea, fatigue and eye irritation. Acute and subchronic oral and inhalation studies of *trans*-1,2-DCE and acute inhalation studies of *cis*-1,2-DCE indicate that the liver is the primary target organ in animals; toxicity being expressed by increased activities of liver associated enzymes, fatty degeneration and necrosis. Secondary target organs include the central nervous system and lung.

Limited information exists on the absorption, distribution, and excretion of 1,2-DCE in either humans or animals. In vitro studies have shown that the mixed function oxidizes will metabolize 1,2-DCE; the final metabolic products are dependent on the initial isomer of 1,2-DCE.

On the basis of an unpublished study describing decreased hemoglobin and hematocrits in rats treated by gavage for 90 days, EPA (1990 a, b) assigned a subchronic and chronic oral RfD for *cis*-1,2-DCE of 1E-1 mg/kg/day and 1E-2 mg/kg/day, respectively. The RfDs were derived from a NOAEL Lowest Observed Adverse Affect Level (LOAEL) of 32 mg/kg/day. An inhalation RfC for *cis*-1,2-DCE has not been derived.

Subchronic and chronic RfDs of 2E-1 mg/kg/day and 2E-2 mg/kg/day, respectively, for *trans*-1,2-DCE have been calculated. The RfDs were derived from a LOAEL of 175 mg/kg/day based on the increase of serum alkaline phosphatase activity in mice that received *trans*-1,2-DCE in their drinking water. An RfC for *trans*-1,2-DCE has not been derived.

No information was available concerning the chronic, developmental or reproductive toxicity of *cis*-1,2-DCE or *trans*-1,2-DCE. No cancer bioassays or epidemiological studies were available to assess the carcinogenicity of 1,2-DCE. EPA has placed *cis*-1,2-DCE in weight-of-evidence Group D (not classifiable as to human carcinogenicity) based on the lack of human or animal carcinogenicity data and on essentially negative mutagenicity data. *Trans*-1,2-DCE has not been classified.

Because of its volatility, the primary route of 1,2-DCE exposure to humans is by inhalation, although dermal and oral exposure can occur. Exposure to 1,2-DCE may occur as a result of releases from production and use facilities, from contaminated waste disposal sites and wastewater, and from the burning of polyvinyl and vinyl copolymers. 1,2-DCE contaminates groundwater supplies by leaching from waste disposal sites. Therefore, human oral, dermal, and inhalation exposure can occur from drinking and using water, and by breathing vapors from 1,2-DCE-contaminated supplies and delivery systems.

#### *Tetrachloroethene (PCE)*

PCE is a halogenated aliphatic hydrocarbon. It is a colorless liquid with a molecular weight of 165.85 and a vapor pressure of 17.8 mm Hg at 25°C. PCE has a half-life of 47 days in the atmosphere and 30 to 300 days in surface water and groundwater. PCE is used primarily as an industrial solvent for a number of applications, and is routinely used in laundry and dry cleaning operations. Inhalation exposure is the primary concern for workers. The general public can also be exposed to PCE by inhalation, mainly in areas of concentrated industry and population. Some of the highest outdoor air levels (up to 58,000 ppt) have been associated with waste disposal sites. Exposure can also occur through contact with contaminated food and water supplies. An estimated 7 to 25 percent of the water supply sources in the United States may be contaminated with PCE.

The main targets of PCE toxicity are the liver and kidneys by both oral and inhalation exposure, and the central nervous system (CNS) by inhalation exposure. Acute exposure to high concentrations of the chemical (estimated to be greater than 1500 ppm for a 30-minute exposure) may be fatal. Chronic exposure causes respiratory tract irritation, headache, nausea, sleeplessness, abdominal pains, constipation, cirrhosis of the liver, hepatitis, and nephritis in humans; and microscopic changes in renal tubular cells, squamous metaplasia of the nasal epithelium, necrosis of the liver, and congestion of the lungs in animals.

RfDs for chronic and subchronic oral exposure to PCE are 0.1 mg/kg/day and 0.01 mg/kg/day, respectively (Buben and Flaherty, 1985; USEPA, 1990; 1991). These values are based on hepatotoxicity observed in mice given 100 mg PCE/kg body weight for six weeks and a NOAEL of 20 mg/kg.

Epidemiological studies of dry cleaning and laundry workers have demonstrated excesses in mortality due to various types of cancer, including liver cancer, but the data are regarded as inconclusive because of various confounding factors. The tenuous finding of an excess of liver tumors in humans is strengthened by the results of carcinogenicity bioassays in which PCE, administered either orally or by inhalation, induced hepatocellular tumors in mice. PCE was negative for tumor initiation in a dermal study and for tumor induction in a pulmonary tumor assay.

Based on the sufficient evidence from oral and inhalation studies for carcinogenicity in animals and no or inadequate evidence for carcinogenicity to humans, PCE is placed in EPA's weight-of-

evidence Group B2 (probable human carcinogen). For oral exposure, the slope factor is  $5.1 \times 10^{-2}$  (mg/kg/day)<sup>-1</sup>; the unit risk is  $1.5 \times 10^{-6}$  (mg/L)<sup>-1</sup>. For inhalation exposure, the slope factor was calculated as  $2.03 \times 10^{-3}$  from the unit risk of  $5.2 \times 10^{-7}$  (mg/m<sup>3</sup>)<sup>-1</sup>.

### *Trichloroethene (TCE)*

TCE is a colorless, stable liquid with a chloroform like odor. It has a molecular weight of 131.5, a vapor pressure of 60mm Hg at 20°C, and a solubility of 1,100 mg/l at 25°C. TCE is considered slightly soluble in water and is miscible with common organic solvents. TCE is used as a metal degreaser, as an extraction solvent for oils, fats, and waxes, for solvent dyeing, in dry cleaning, and for cleaning and drying electronic parts.

Inhalation exposure is the most likely route for human contact with TCE. Systemic health effects have generally been reported only when people are exposed to TCE levels above the odor threshold. There are a few case reports of humans exhibiting kidney and liver damage following exposure to very large amounts of TCE.

There is no reliable information concerning the adverse systemic effects of chronic exposure to levels of TCE below the threshold limit value of 50 ppm. Neurological effects reported in workers exposed for less than 15 years to relatively high mean TCE levels (167 ppm) include vertigo, fatigue, headache, and short-term memory loss. The number of symptoms increased with cumulative exposure time.

EPA's IRIS database currently does not list a chronic oral or inhalation RfD for TCE. The chronic systemic toxicity of TCE is currently under review by the RfD workgroup. Pending this review, a provisional chronic oral RfD of 6E-3 mg/kg-day was issued by ECAO (now NCEA) in 1992, based on the subchronic mouse study by Tucker, et al (1982). The critical effect seen in this study was liver toxicity following oral administration.

Animal studies have shown increases in cancers of various types following inhalation or oral exposure to TCE. These cancer types include cancer of the liver and forestomach in mice, and cancer of the kidney and testes in rats. It is believed that tumor production by TCE is the result of metabolites of TCE. There are differences between high- and low-dose metabolism of TCE, as well as differences between species' susceptibility to cancer. Given that enormous worker populations have been exposed to TCE, and that only a small number of persons have experienced chronic effects, it is possible that TCE is not metabolized to the active carcinogen level in humans at low environmental doses. The mechanisms of carcinogenicity are not known. EPA has classified TCE as a Class B2 (adequate evidence in animals but insufficient evidence in humans) carcinogen.

Mutagenesis studies have suggested that TCE is only very weakly genotoxic following metabolic activation. The Health Assessment Document concludes that there is insufficient evidence to prove that TCE is mutagenic.

### *1,1,1-Trichloroethane (1,1,1-TCA)*

1,1,1-TCA (1,1,1,-TCA-methylchloroform) has a sweet odor that may be noticeable at concentrations near 100 ppm, significantly lower than those that cause physiologic response. At 1000 ppm the odor is not unpleasant enough to discourage exposure; at 1500 and 2000 ppm, the odor is strong and unpleasant. 1,1,1-TCA has a molecular weight of 133.42, a specific gravity of 1.3249 (26/4°C), and a vapor pressure of 127 torr at 25°C. It is soluble in acetone, benzene, carbon tetrachloride, methanol, and ether, but insoluble in water.

1,1,1-TCA is absorbed through inhalation, oral, and dermal exposure routes. Clearing of the chemical from the blood is rapid following exposure; 60 to 80 percent is eliminated within 2 hours, and more than 95 percent is eliminated within 50 hours. A large fraction of the absorbed dose is excreted unchanged in exhaled air regardless of the route of exposure. The chemical has been detected in the fat, liver, kidney, brain, muscle tissue, and skin of animals. Humans metabolize less than 10 percent of the inhaled dose of 1,1,1-TCA.

Little is known about the oral toxicity of 1,1,1-TCA. One case study reported gastrointestinal and hepatic effects in an individual who accidentally ingested approximately 600 mg/kg of the chemical. Death in most cases has been attributed to depression of the central nervous system resulting from anesthesia.

### *1,2-Dichloropropane*

1,2-Dichloropropane is a colorless liquid with the odor of chlorinated solvent. The chemical is volatile and evaporates quickly at room temperature. It is used as an industrial solvent for fats, oils, resins, waxes, and rubber; in manufacturing photographic film; and for coating paper. Experiments in animals have shown that when 1,2-dichloropropane enters the body through ingestion, is removed quickly in urine and feces and by the lungs during exhalation.

Human ingestion through drinking (e.g., drinking cleaning solutions) has resulted in poisoning. At high levels of exposure, effects include dizziness, headache, nausea, injury to the liver and kidneys, anemia, coma, and ultimately death. There have been reports of health effects in humans following low level exposure for either short or long periods. Exposure has not been shown to cause cancer in humans, but long-term exposure in animals has produced evidence of liver cancer in mice and breast cancer in female rats.

The major releases of 1,2-dichloropropane are to the atmosphere and to soil. When applied to soil or landfilled, it partially volatilizes and the remainder leaches into subsurface soil and groundwater. Volatilization is unlikely in groundwater, where the principal reactions are hydrolysis and anaerobic biotransformation. Therefore, groundwater supplies contaminated with 1,2-dichloropropane may remain so for a long time.

### *Vinyl Chloride (VC)*

In humans, exposure to VC can result in irritation of the respiratory tract, bronchitis, headache, irritability, memory disturbances, and tingling sensations. Acute occupational exposure to high concentrations of VC can produce symptoms of narcosis, and may even lead to death. In animals ataxia, narcosis, blood-clotting difficulties, congestion and edema in lungs, and kidney and liver effects have been observed. At high doses, excitement, convulsions and an increase in respiration followed by respiratory failure precede death. Human health effects associated with chronic occupational exposure to VC include hepatitis-like liver changes, decreases in blood platelets, enlarged spleens, decreased pulmonary function, cardiovascular and gastrointestinal toxicity, and disturbances in vision and the central nervous system.

VC is a known human carcinogen that causes liver angiosarcomas ( a rare tumor in humans) and possibly increases the incidence of tumors of the brain, the lung, and the hemolymphopoietic system in humans. VC is carcinogenic in mice, rats, and hamsters.

VC is mutagenic in several test systems. Chromosome aberrations have been reported in exposed workers. In humans, possible relationships between exposure and birth defects and fetal death have been reported. Increased skeletal variants were found in offspring of mice exposed during gestation.

### *Benzene*

Benzene is a clear, volatile, colorless, highly flammable liquid having a characteristic odor. Benzene occurs naturally in many plants and animals and also serves as a major industrial chemical produced from coal and oil. In industry, benzene is used as a solvent and as a component of motor fuels, such as gasoline. Due to the quick evaporation rate of benzene, the most common route of exposure to humans is through inhalation of contaminated air. Small amounts of benzene are found in some foods, in contaminated drinking water, and in cigarette smoke. Benzene is absorbed into the blood stream from either the gastrointestinal tract after ingestion or into the lungs after inhalation. It may also be absorbed through the skin at a very slow rate. After ingestion or inhalation, humans and animals tend to eliminate benzene unchanged in the exhaled air or in a metabolized form in urine and feces.

The principal acute toxic effect of benzene in humans and other animals is on the central nervous system, the blood-making system, and the immune system. Inhalation of high concentrations of benzene (10,000 to 20,000 ppm for 5 to 10 minutes) may be fatal. Lower-level exposures (700 to 3000 ppm) can cause dizziness, drowsiness, headaches, and unconsciousness. Dermal contact with benzene may cause redness and blisters. Autopsies of persons who have died following inhalation of high concentrations of benzene have shown inflammation of the respiratory tract and damage to the lungs, the kidneys, and the brain. Ingestion of high doses of benzene (10 ml, the reported lethal oral dose for humans) has produced staggering gait, vomiting, shallow and rapid pulse, and loss of consciousness, followed by delirium, pneumonitis, collapse, and sudden depression of the central nervous system, leading to coma and death.

Studies of chronic exposure to benzene by humans and animals have shown that benzene inhibits blood-cell formation and can cause leukemia. Evidence of carcinogenicity also exists. Benzene has been reported as being genotoxic, causing chromosome aberrations in the bone marrow of persons occupationally exposed. A relationship between benzene exposure and development of leukemia has been reported in epidemiological studies. It has been classified as a Group A carcinogen (known human carcinogen) by EPA.

The most significant source of benzene released to the environment is through the combustion of gasoline. It is noted to evaporate easily from surface water and soil, and if released to soil or water may volatilize, photoxidize, and biodegrade. Bioconcentration of benzene in aquatic organisms is not considered likely. Benzene is fairly soluble in water and can leach from soil into groundwater.

### *Ethyl Benzene*

Ethyl benzene is used as an intermediate in producing styrene, in the manufacture of cellulose acetate and synthetic rubber, as a diluent in the paint industry, in agricultural sprays for insecticides, and in gasoline blends. Primary routes of exposure include drinking water, breathing air, and touching soil contaminated with ethyl benzene.

Symptoms of short term human exposure to ethyl benzene include eye, nose, throat, and skin irritation, narcosis (at very high concentrations), dizziness, drowsiness, weakness, and dermatitis. Long-term data are limited, but evidence exists that ethyl benzene may cause liver and kidney injury and that it may be a teratogen at high doses. EPA has classified ethyl benzene as a Group D carcinogen (not classifiable as to human carcinogenicity).

When released to the atmosphere, it exists predominantly in the vapor phase, where it photochemically degrades by reacting with hydroxyl radicals and partially returns to earth in rain. However, it is not subject to direct photolysis. Ethyl benzene in water evaporates and degrades, the primary removal process depends on season, turbulence, and microbial populations. Some of the chemical may be absorbed by sediment, but insignificant bioconcentration in fish is not expected. When released to soil it is moderately absorbed and may leach to groundwater, where biodegradation is possible. Ethyl benzene will not hydrolyze significantly in water or soil.

### *Toluene*

Toluene is a clear, colorless liquid having a sweet odor. It is produced from petroleum refining, as a by-product of styrene production, and as a by-product of coke oven operations. Toluene is used in making paints, lacquers, adhesives, rubber, and in some leather-tanning and printing operations. It enters the body through inhalation, ingestion, or dermal contact. The chemical is absorbed rapidly through the lungs, in the gastrointestinal track, and through the skin. Most of the toluene is removed from the body within 12 hours, either unchanged through expired air or chemically changed through urine.

Acute and subacute inhalation exposure to toluene vapor result in symptoms indicating toxicity to the central nervous system. Animal studies indicate that acute oral toxicity is relatively low. Chronic exposure to toluene vapors has been associated primarily with effects on the central nervous system and, possibly, effects on peripheral systems. Liver and kidney functions may also be effected by chronic exposure. Reproductive effects and birth defects, including cleft palate, delayed skeletal development, and fetotoxicity, have been reported. However, studies of workers and animals exposed to toluene indicate that toluene is not a carcinogen. EPA has classified toluene as a Group D carcinogen.

Toluene is relatively mobile in soil-water systems, including transport of vapor through air-filled pores and transport in solution. It is resistant to hydrolysis but biodegrades readily in the presence of microbial populations. Toluene has a moderate tendency to bioaccumulate in the fatty tissues of aquatic species.

### *Nitrobenzene*

Nitrobenzene is an oily yellow liquid having an almond-like odor. It is manufactured by industry mainly for producing the chemical, aniline. It may also be found in lubricating oils for machinery, dyes, drugs, pesticides, and synthetic rubber. Nitrobenzene may enter the human body through ingestion, inhalation, and dermal exposure. It is eliminated from the body within a few days through the urinary tract.

Medical reports show that acute exposure causes mild irritation of the skin and eyes. Chronic exposure decreases the blood's ability to carry oxygen, and may cause vomiting, shortness of breath, and nausea. Other possible symptoms of exposure include irritability, weakness, headache, dizziness, and drowsiness. Extremely high exposure may induce a coma and even death if medical attention is not received promptly.

Nitrobenzene enters the environment through releases to water and air in liquid form. The chemical will biodegrade in a matter of days and is only slightly mobile in water.

### *Arsenic*

The toxicity of inorganic arsenic (As) depends on its valence state and on the physical and chemical properties of the compound in which it occurs. Trivalent (As+3) compounds are generally more toxic than pentavalent (As+5) compounds, and the more water-soluble compounds usually are more toxic and more likely to cause systemic effects than the less soluble compounds. The less soluble compounds are more likely to cause chronic pulmonary effects if inhaled.

Water soluble inorganic As compounds are absorbed through the gastrointestinal tract and the lungs; distributed primarily to the liver, kidney, lung, spleen, aorta, and skin; and excreted mainly in urine at rates as high as 80 percent in 61 hours after oral dosing. Symptoms of acute inorganic arsenic poisoning in humans are nausea, anorexia, vomiting, epigastric and abdominal



pain, and diarrhea. Oral doses as low as 20 to 60 mg/kg/day have reportedly caused toxic effects in some individuals. General symptoms of chronic As poisoning in humans are weakness, general debility and lassitude, loss of appetite and energy, loss of hair, hoarseness of voice, weight loss, and mental disorders. Primary target organs are the skin and the vascular system.

Epidemiological studies have revealed an association between As concentrations in drinking water and increased incidence of skin cancers and cancers of the liver, bladder, and respiratory and gastrointestinal tracts. Occupational-exposure studies have shown a clear correlation between exposure to As and mortality from lung cancer. EPA has placed inorganic arsenic in Group A, human carcinogen. Arsenic is cleared from the body relatively rapidly, primarily in urine, but also in hair and nails.

### *Aluminum*

Aluminum is a silver-white flexible metal that occurs naturally combined with other elements as ore in the earth's crust. Aluminum is used in antacids and deodorants, and as a metal in cooking utensils, appliances, and building materials. The main route of absorption is through ingestion. The extent of absorption depends somewhat on the chemical form. Trivalent aluminum is absorbed into the intestinal mucosa to a minor extent and then is transferred into the lungs, plasma, bone, and cells of various organs. Aluminum is excreted in feces and to a limited extent in urine.

The acute toxicity of aluminum is not well defined. Possible target organs include the brain and bone. Inhalation of aluminum dust has resulted in irritation of airways and possible fibrosis of the lungs in aluminum-industry workers. Acute dermal exposure in humans has resulted in skin rashes. Chronic exposure has been associated with Alzheimer's disease in humans. At autopsy, neurofibrillary tangles containing aluminum have been found in the cerebral cortex and hippocampus of Alzheimer patients.

Aluminum partitions into air, water, soil, and plant material. It is transported in the atmosphere as a constituent of soil and other particulate matter. Transformation is not expected in the atmosphere. Aluminum partitions between the soil-sediment and aqueous phases by reacting and complexing with water molecules, anionic compounds, and negatively charged functional groups on humic materials and clay. Bioaccumulation does not appear significant.

### *Antimony*

Antimony is a silvery-white metal of medium hardness that breaks easily. It is used as a component of lead and zinc alloys that are used in lead storage batteries, solder, sheet and pipe metal, bearings, castings, type metal, ammunition, and pewter. Exposure may occur through ingestion of food or water, through breathing air, or through contact with soil, water, or other substances that contain antimony. Skin contact and inhalation are common occupational exposures. Most absorbed antimony is transported to the liver, the lungs, the intestines, and the spleen. Within several weeks antimony is excreted in feces and urine.

Acute symptoms of antimony exposure are diarrhea, vomiting, gastric discomfort, and ulcers following oral ingestion of large quantities. Animal studies indicate that acute exposure may result in lung, heart, liver, and kidney damage, eye irritation, and skin irritation. Subchronic exposure through inhalation leads to heart problems, stomach ulcers, pneumoconiosis, and eye and skin irritation. Animal studies indicate that subchronic ingestion may cause diarrhea, weight loss, liver damage, and decreased red blood cell count.

Antimony in the atmosphere is in the form of particulate matter or is absorbed to particulate matter. It is transported to land and surface water through gravitational settling and other forms of dry and wet deposition. In the aquatic environment, antimony tends to settle out in areas of active sedimentation. Some forms of antimony are strongly sorbed to soil, making it relatively immobile. It may also absorb strongly to colloidal materials in soil and may be transported to groundwater. Antimony does not appear to bioconcentrate in fish and aquatic organisms.

### *Beryllium*

Beryllium is a naturally occurring dark-gray metal of the alkaline earth family. Natural atmospheric emissions of beryllium originate from volcanic particles and windblown dust. The source is small in comparison to the anthropogenic sources such as ore processing and coal and fuel combustion. Bertrandite ore deposits are mined and processed to produce beryllium metal, alloys, and oxide. These forms of beryllium have commercial uses in certain items, such as electrical components, tools, and structural components for aircraft, missiles, and satellites.

Inhalation of beryllium is the major route of environmental exposure. Both oral and dermal exposure are secondary routes since absorption by the gastrointestinal tract and the skin is poor. When absorbed, beryllium circulates in the bloodstream as an orthophosphate colloid. Distribution favors the skeleton, liver, and kidneys. After inhalation exposure, most of the absorbed beryllium is excreted in urine.

The lungs are the primary organ affected by beryllium exposure. Studies show that acute exposure to an aerosol of soluble beryllium results in chronic pneumonitis in laboratory animals and in humans exposed in the workplace. Acute dermal exposure to soluble beryllium compounds causes contact dermatitis.

There is no evidence indicating that beryllium produces a carcinogenic response following oral or dermal exposure in animals or humans. Evidence exists that various inhaled beryllium compounds can induce lung tumors in monkeys and several strains of rats. EPA classifies beryllium as a B2 carcinogen (probable human carcinogen), although human epidemiology studies of workplace exposure are inadequate to clearly establish human carcinogenicity.

Due to low solubility, beryllium oxide is not expected to be mobilized in soil or surface water of normal pH (5 to 8). Beryllium is expected to be absorbed tightly in most soil types since it displaces divalent cations. Therefore, environmental movement through leaching from soil or solubilizing in the water column appears minimal.

## *Cadmium*

Cadmium is naturally occurring bluish-white metal usually found in combination with other elements (cadmium oxide, cadmium chloride, and cadmium sulfide). These compounds are stable solids. Since many edible plants and fish take up cadmium from soil or water sources, food is the primary exposure route for humans. Airborne exposures also can occur. Cadmium is poorly absorbed from the gastrointestinal tract after ingestion but relatively well absorbed from the lungs after inhalation.

Acute oral and inhalation exposure results in severe irritation to the stomach and lungs. At high doses, injury to the testes and liver may occur. The kidney is the major target organ. Reproductive and developmental effects also have been observed in animals. In addition, evidence of lung fibrosis emphysema and lung cancer in humans are associated with chronic exposure to inhaled cadmium. EPA classifies cadmium as a Group B1 (probable human carcinogen with limited human data available).

In surface water or groundwater, cadmium can exist as a hydrated ion or as ionic complexes with organic or inorganic ligands. It may also exist in insoluble forms and be absorbed to particulate matter, soil and sediment. Cadmium is bioaccumulated in microorganisms through exposure to food and water.

## *Chromium*

Chromium is a naturally occurring steel-gray lustrous metal used in metal alloys, chrome plating, and various other industrial processes. It occurs naturally in foods and is considered vital to the metabolism of fats and sugars. Chromium appears in several chemical states, with hexavalent chromium being the most toxic and most often seen in waste streams. Absorption occurs through inhalation, ingestion, and skin contact. Although it can accumulate in various organs, particularly the lungs, the majority of absorbed chromium is excreted quickly through the urinary tract.

Inhalation of chromium by workers for less than one year has resulted in irritation of the mouth and throat, sneezing, redness of the throat and generalized bronchial spasms. Dermal exposure results in skin ulcers that may penetrate deeply into soft tissue. Accidental ingestion by humans has resulted in intense gastrointestinal effects, bleeding, circulatory collapse, unconsciousness, and death. Epidemiological evidence indicates a strong relationship between occupational chromium exposure and respiratory-system cancers, particularly lung, bronchogenic, and nasal cancer. EPA classifies chromium as a Group A carcinogen (human carcinogen).

Airborne chromium is removed from the atmosphere primarily by fallout and precipitation and enters surface water and soil. It does not absorb to clay or other inorganic surfaces. Chromium is mobile in groundwater and in aquatic media, will filtrate into the sediment. The chemical does not bioconcentrate in fish and there is no evidence of biomagnification of chromium along the

aquatic food chain. Some data indicate that chromium has a low mobility for translocation from roots to aboveground plants.

### *Manganese*

Manganese is a naturally occurring metal that is mixed with iron to make steel, used in producing batteries, and used as a component of some ceramics, plastics, and fertilizers. It is an essential nutrient for humans. Following oral exposure, most manganese is excreted in feces, and about three to five percent is taken up and stored in the body. Manganese-contaminated dust may become trapped in the lungs following inhalation, and some of the particles may then dissolve in the lungs and enter the bloodstream. Manganese is not readily absorbed through the skin.

Chronic inhalation exposure to manganese dust in occupational settings has shown strong evidence of severe neurological damage in humans. A disease, known as "manganism", typically begins with feelings of weakness and lethargy. As the disease progresses, the central nervous system can be affected and psychological disturbances can occur. In advanced cases, permanent muscle rigidity may develop. EPA has assigned a weight-of-evidence classification of Group D (no conclusive evidence as to human carcinogenicity) for manganese.

Manganese may occur in the air as suspended particles and will settle out according to particle size. Depending on its chemical form, manganese may be soluble in water, and is often transported in rivers as suspended sediment. The absorption of manganese to soil is highly variable and depends on soil composition. Lower organisms, such as algae, appear to bioconcentrate manganese, but higher organisms do not. This suggests that biomagnification in the food chain is not significant.

### *Nickel*

Nickel is a silvery metal occurring naturally in Earth's crust in various minerals. Nickel and its compounds are found in the air, groundwater, surface water, and oil. Industrial nickel is obtained from mined ore and recycled scrap metal. Industrial metal is used predominantly in making various steels and alloys and in electroplating. Other uses include electrical contacts and electrodes, spark plugs, machinery parts, nickel-chrome resistance wire, stainless steel, and electronic and space applications.

Studies indicate that humans absorb little nickel following inhalation or oral exposure. Limited dermal absorption has been demonstrated in both humans and animals. Regardless of the exposure route, nickel is excreted in urine, hair, and sweat in both humans and animals. Nickel is an essential element for maintaining health in animals and possibly humans. The most prevalent effect of nickel in the general population is contact dermatitis. The respiratory system is the major target organ following inhalation exposure. Effects in both humans and animals include bronchitis, decreased lung capacity, asthmatic disease, and allergic responses. Other target systems of nickel include the kidney and the immune system. Nickel refinery dust has been classified as a Group A carcinogen (known carcinogen).

Atmospheric nickel is emitted primarily in burning fuel oil and occurs predominantly as nickel sulfate. Both wet and dry deposition of nickel aerosols occur. Nickel is constantly being transferred between the environmental media through natural processes, such as weathering, erosion, leaching, and runoff. Processes, such as complexation, precipitation/dissolution, adsorption/desorption, and oxidation/reduction reactions, control the mobility of nickel in aquatic media. There is no data indicating that water or soil microorganisms biotransform nickel. Some, but not all, aquatic organisms are reported to bioaccumulate nickel.

### *Thallium*

Pure thallium is a soft bluish-white metal that is widely distributed in trace amounts in Earth's crust. In the pure form it is odorless and tasteless. Thallium exists in two states, thallos and thallic. The thallos state is the more common and stable form, and thallos compounds are the most likely form to which humans may be exposed. Thallium is most commonly used in manufacturing electronic devices, switches, and closures and has limited use in the manufacture of special glasses and certain medical procedures. Until 1972, thallium was used as a rat poison, but was then banned due to its potential harm to humans. The chemical can enter the body through all exposure routes. When swallowed, most of it is rapidly distributed to various parts of the body, especially the kidney and the liver.

Thallium can affect the nervous system, the lungs, the heart, the liver, and the kidneys if large amounts are ingested over a short time. Temporary hair loss, vomiting, and diarrhea also can occur and death may result after exposure to large amounts of thallium (1 to 4 mg/kg/day) for short periods. It can be fatal at a dose as low as one gram. Animal reproductive organs, especially the testes, were damaged after small amounts of thallium-contaminated water were drunk for two months. No studies were found on whether thallium can cause cancer to humans or animals. EPA has assigned a classification of Group D (not classifiable for human carcinogenicity) to several thallium compounds. Thallium tends to sorb to soil and sediment and may be bioconcentrated by organisms from water.

### *Zinc*

Zinc is a metal found naturally in air, soil, water, and food, and is an essential trace element needed by the body. Zinc has many uses in industry in its pure form or mixed with other metals as an alloy. It is absorbed after oral ingestion from all segments of the intestines, and zinc dust may be absorbed through the lungs and to a limited extent, the skin. The metal-binding protein, metallothionein, controls the intestinal transport of zinc and also prevents excess absorption. Metallothionein binds zinc in intestinal mucosal cells, and the cells are sloughed off and excreted when the system is saturated. High levels of calcium and phosphate in the intestines decrease absorption of zinc, while the presence of protein enhances absorption.

Acute inhalation exposure to zinc oxide causes a syndrome known as "metal fume fever." Clinical signs include cough, nasal irritation, decreased lung volume, and chest pain, and the symptoms usually diminish in 24 to 48 hours. Oral ingestion of large amounts of zinc produces

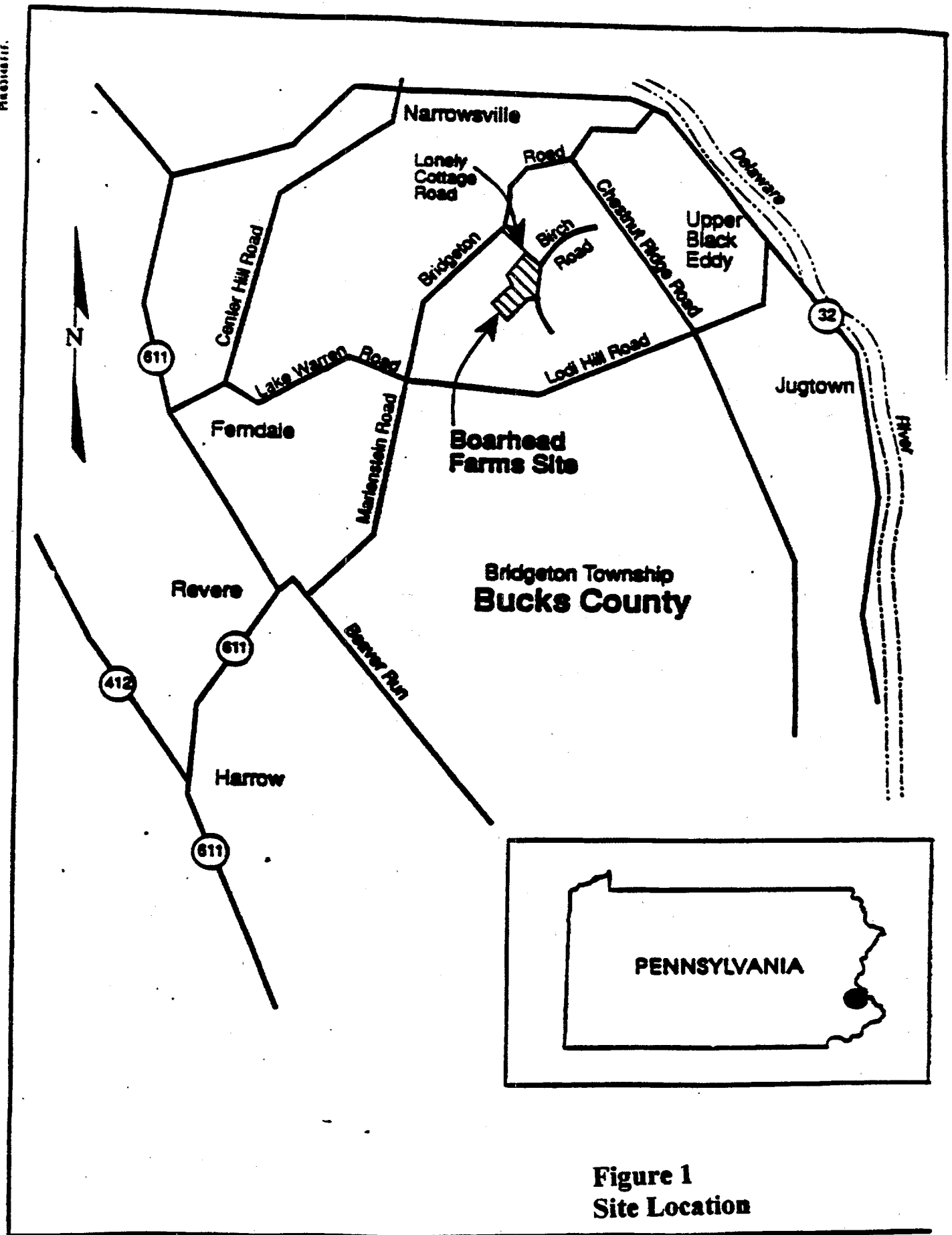
gastrointestinal distress, with burning and pain in the mouth and throat, and vomiting. Individuals occupationally exposed to airborne zinc oxide developed lung-tissue damage in the alveolar region.

In the environment, zinc tends to exist in the divalent oxidation state. Atmospheric zinc has not been studied comprehensively, but the belief is that it exists sorbed to particulate matter. Aquatic zinc is present in suspended and dissolved forms. It may also partition onto sediment, suspended solids, hydrous iron, and manganese oxides, as well as sorbing to clay minerals and organic material. Zinc is strongly sorbed in soils and bioaccumulates in fish, crustaceans, and plants.

APPENDIX B - FIGURES

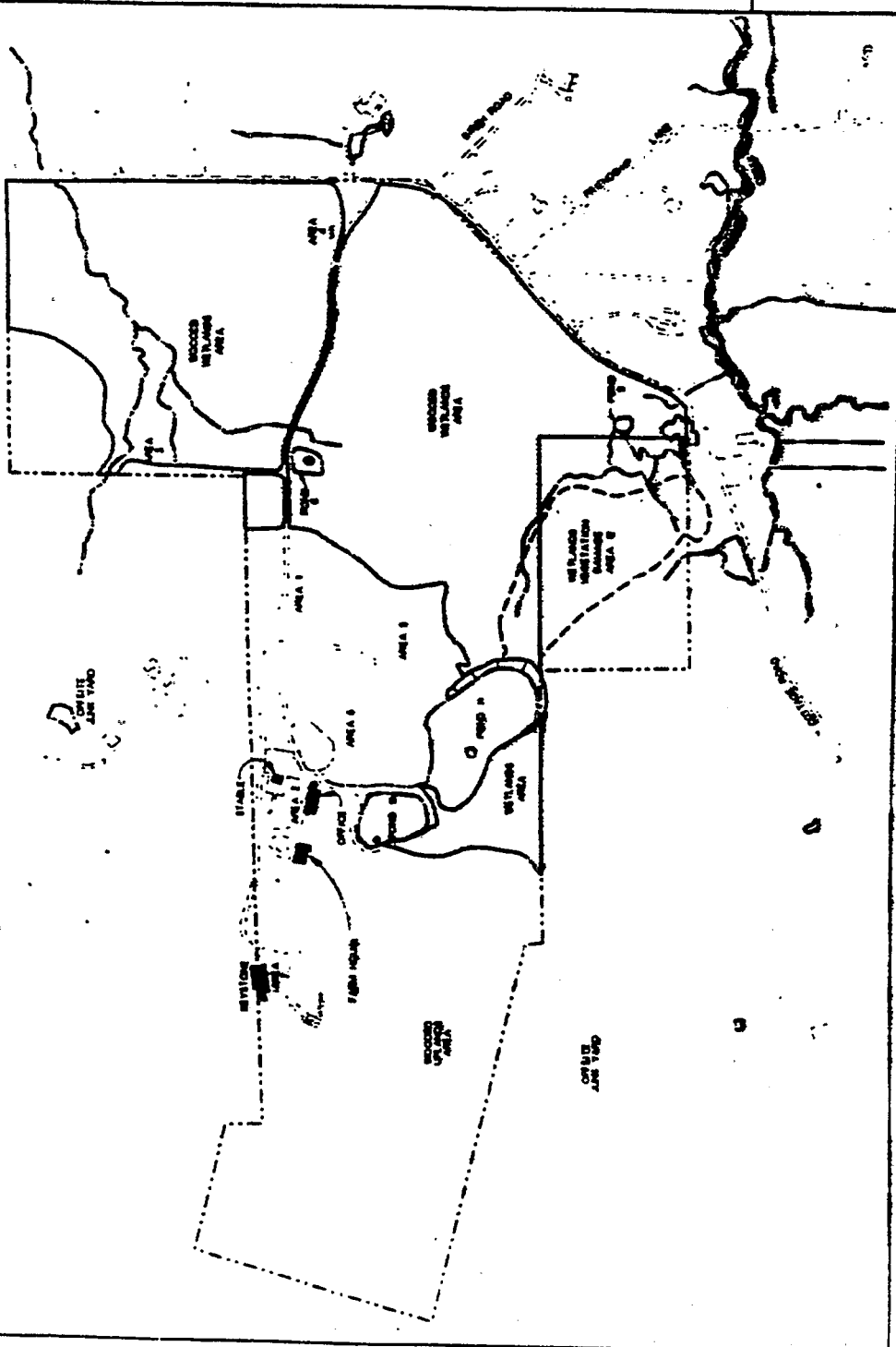




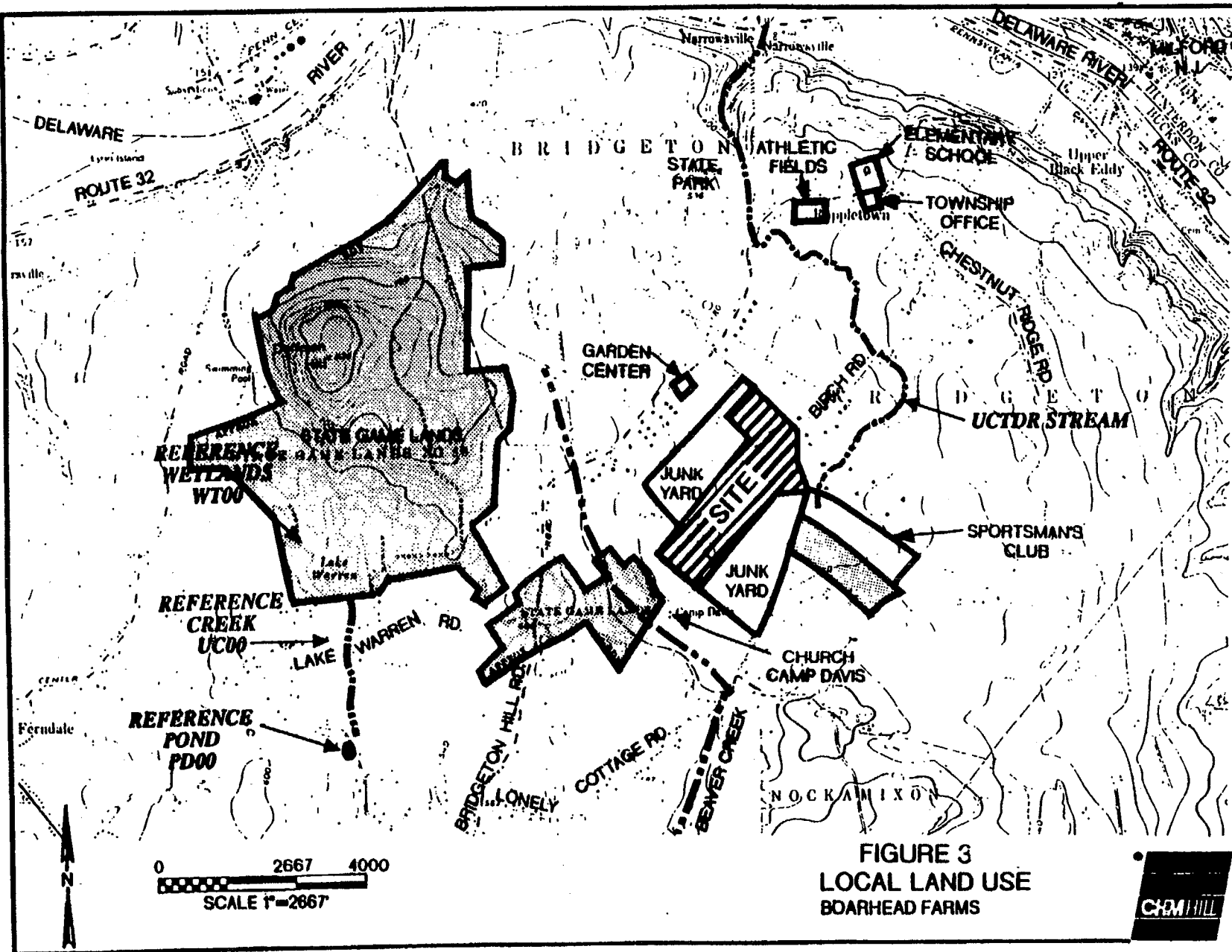


**LEGEND**

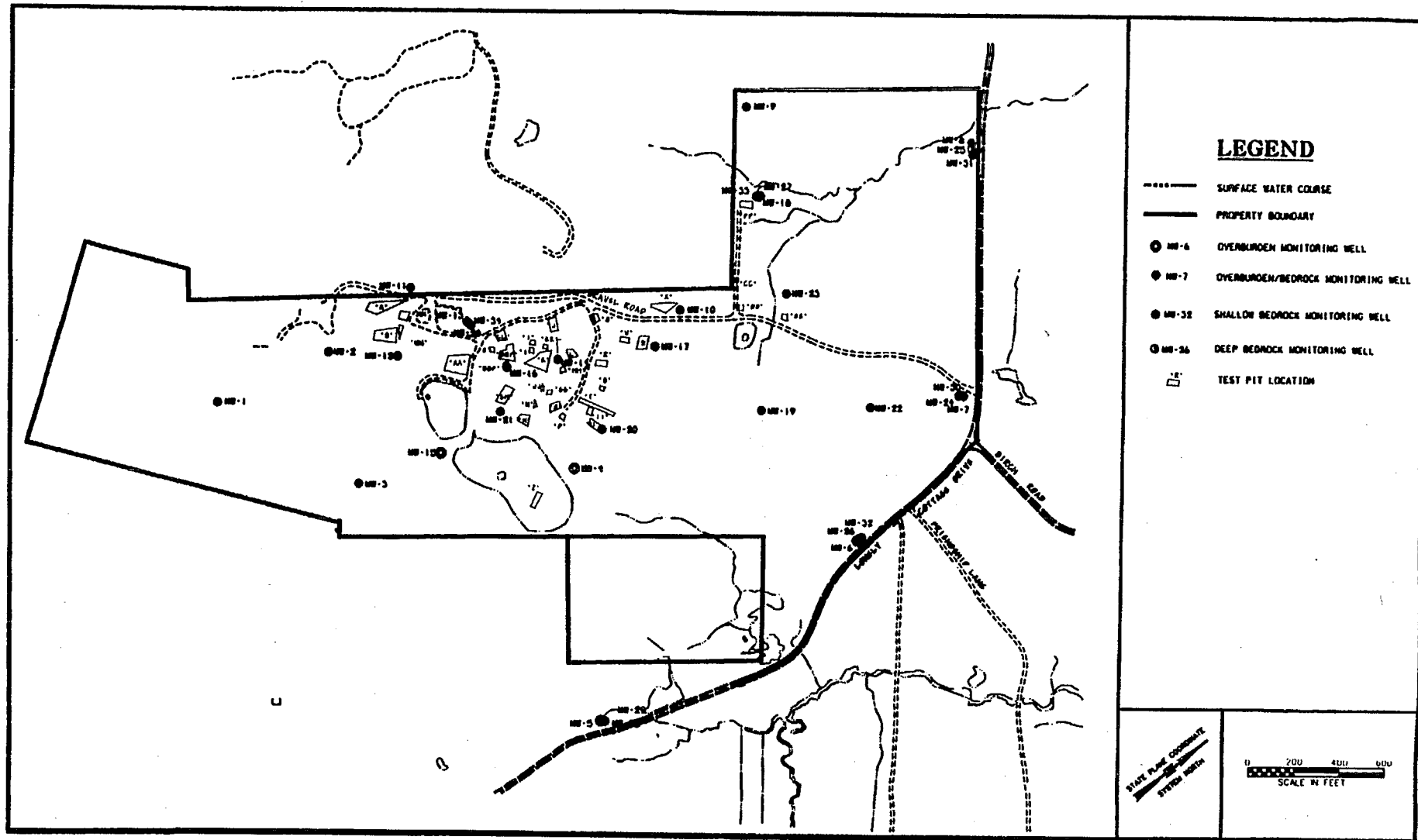
- SURFACE WATER COURSE
- - - PROPERTY BOUNDARY
- BALTIC
- WOODED WETLANDS
- AREA OF WETLAND  
WITH POTENTIAL DAMAGE



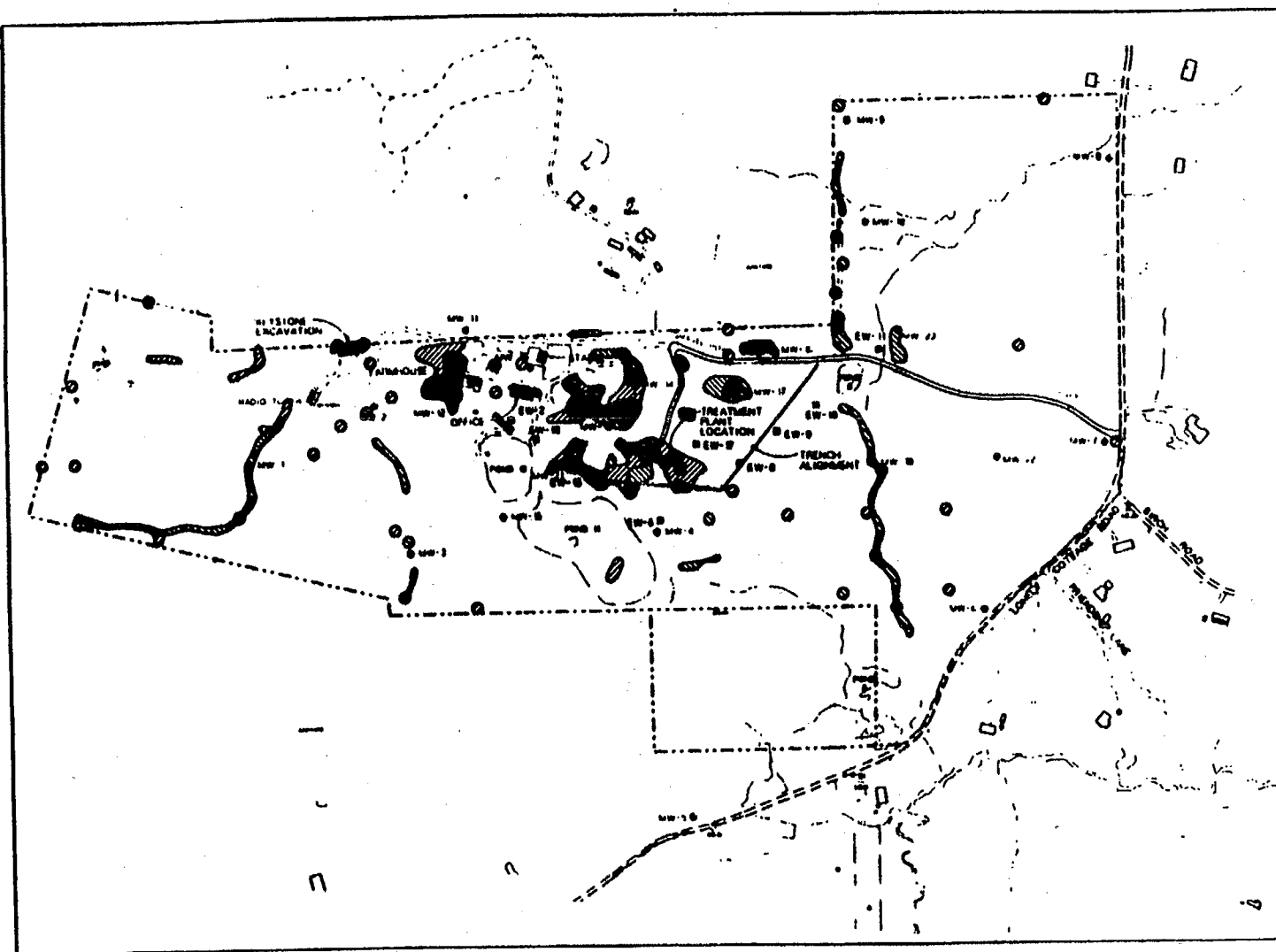
**Figure 2**  
**SITE FEATURES**  
**WETLANDS AND POTENTIAL DAMAGE**



**FIGURE 3**  
**LOCAL LAND USE**  
**BOARHEAD FARMS**



**FIGURE 4**  
**MONITORING WELL AND TEST PIT**  
**LOCATIONS**  
 BOARHEAD FARMS  
 UPPER BLACK EDDY, PENNSYLVANIA



# LEGEND

- SURFACE WATER COURSE
- - - PROPERTY BOUNDARY
- MW-1 MONITORING WELL LOCATION
- EW-1 EXISTING EXTRACTION WELLS INSTALLED FOR THE PND
- - - EXISTING GROUNDWATER COLLECTION TRENCH INSTALLED BY USACE
- ▨ APPROXIMATE EXTENT OF ORGANIC CONTAMINANT IN SOIL
- ▩ APPROXIMATE EXTENT OF INORGANIC CONTAMINANT IN SOIL

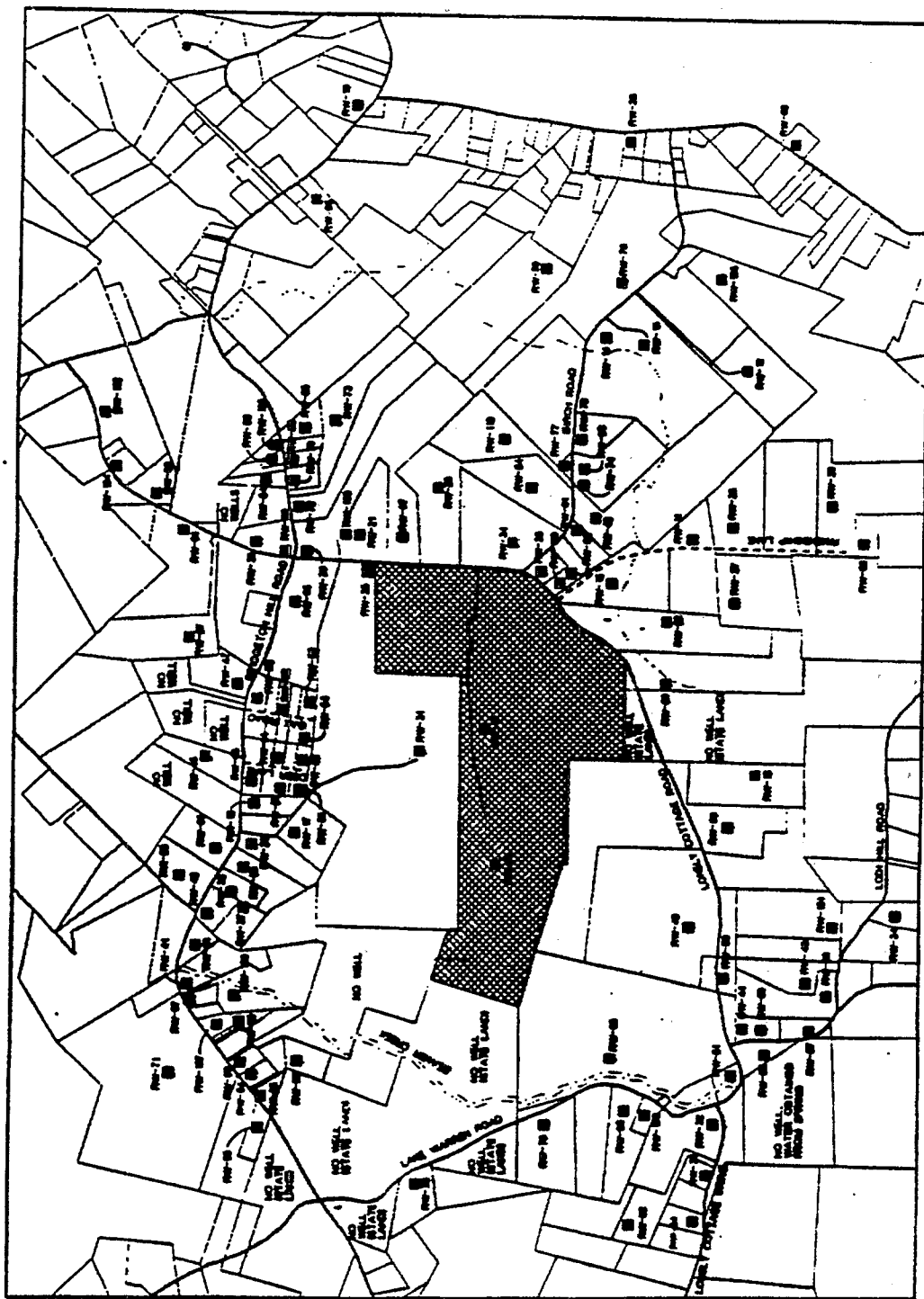
STATE PLANT COMMISSION  
2-10-80  
100 FEET

0 100 200  
FEET

Figure 5

EXISTING GROUNDWATER  
COLLECTION SYSTEM AND  
DISTRIBUTION OF ORGANIC  
AND INORGANIC CONTAMINATION  
IN SUBSURFACE SOILS  
BOARDMAN FARMS, PND  
UPPER MERION, PENNSYLVANIA



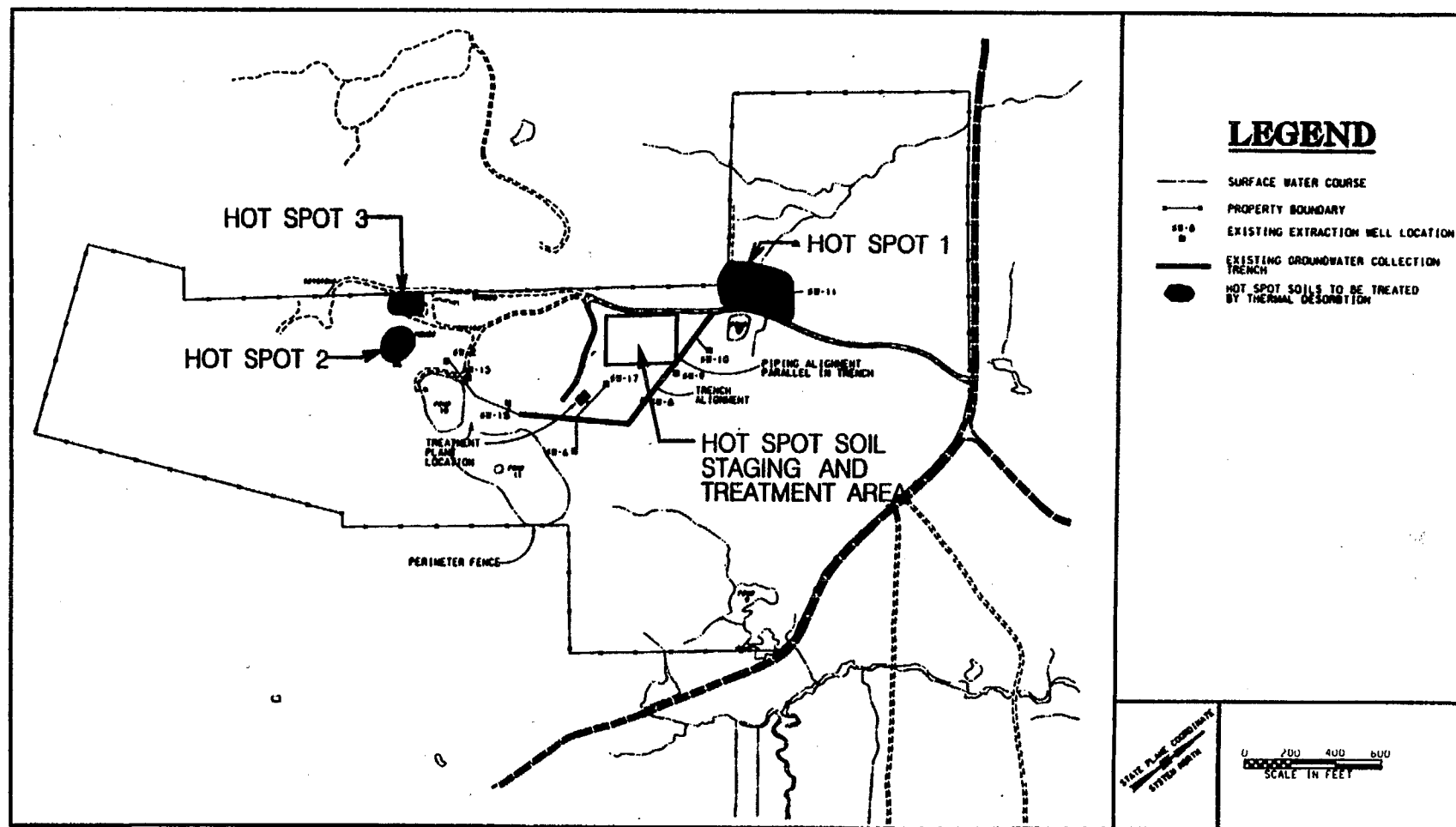


# LEGEND

- PW-10 RESIDENTIAL WELL LOCATION AND STATION NUMBER
- SURFACE WATER COURSE
- UNIMPROVED ROAD
- BOARDWALK FARM SITE

NOTE:  
THE LOCATION OF PW-10 IS NOT  
SHOWN ON THIS MAP.

**Figure 6**  
RESIDENTIAL WELL LOCATIONS  
POMEREAU FARMS RIFLES  
UPPER BLACK EDDY, PENNSYLVANIA



**FIGURE 7**  
**HOT SPOT REMOVAL AREAS**  
**BOARHEAD FARMS**  
**UPPER BLACK EDDY, PENNSYLVANIA**





## APPENDIX C - TABLES



Table 1  
Areas of Investigation

Area 1	Large open field in the north-central part of the Site. Includes area on both sides of the entrance road. This is area of ammonia release in 1976 and where the presence of tanks, drums, and trailers has been documented.
Area 2	Includes farmhouse, office, and stables. Evidence that tanks and chemicals were stored in this area.
Area 3	North of Area 1; tanks and other objects have been stored. Tanks from this area were moved to Area 1 during RI activities.
Area 4	Area closest to and just north of entrance road. Aerial photographs indicate ground disturbance or excavation.
Area 5	Cleared area just south of Area 1. Documented presence of tanks and other objects in the area in 1970s. Includes an area containing burned oil filters.
Area 6	Large area between ponds and Area 2. Presence of a fill area and standing liquid noted in aerial photographs.
Area 7	Area surrounding and including the operating Keystone Excavation building.
Pond 8	Pond at east end of Area 1. Drainage from Area 1 enters the pond.
Pond 9	Small detention pond in southeast corner of the Site that receives drainage from swamp. Reportedly, lime was added to neutralize discharges of acidic surface water.
Pond 10	Pond just south of the Area 2 farmhouse. Standing liquid noted in aerial photographs before the presence of the pond.
Pond 11	Large pond south of Area 5. High contaminant concentrations in surface water and sediment measured during the Site investigation before construction of the pond.
Area 12	Swamp area east of large pond to Site boundary. Received drainage from ferrous chloride spill. Formerly wooded wetland until disturbed by Site discharges.
Unnamed Creek	Unnamed tributary of the Delaware River (unnamed creek) that receives surface runoff from the Site through five culverts that flow beneath Lonely Cottage Road.
Groundwater	Aquifer(s) beneath and downgradient of the Site that are affected by Site activities.

Table 2

Monitoring Well Locations Where Federal MCLs or State HALs Were Exceeded in Groundwater  
Boarhead Farms RI/FS

	Wooded Uplands					Farmhouse Area 2					Areas 5 and 6				
	MW-01	MW-02	MW-03	MW-09	MW-11	MW-12	MW-13	MW-28	MW-34	MW-15	MW-04	MW-14	MW-16	MW-20	MW-21
<b>Pesticides</b>															
Aldrin												H			
BHC-Gamma											M				
Dieldrin	H		H	H	H						H				
<b>Semivolatile Organic Compounds</b>															
2,4-Dichlorophenol											H	H		H	
4-Nitrophenol															
Naphthalene													H	H	H
<b>Volatile Organic Compounds</b>															
1,1,1-TCA											M	M	M	M	M
1,1,2-TCA											M	M	M	M	M
1,1-DCE											M	M	M	M	M
1,2-Dichlorobenzene											M	M	M	M	M
1,2-DCA						M						M		M	M
1,2-Dichloropropane						M									
1,4-Dichlorobenzene															
Benzene						M					M	M	M	M	M
Carbon Tetrachloride											M		M	M	M
cis-1,2-DCE						M					M		M	M	M
Ethylbenzene													M	M	M
Methylene Chloride													M		M
PCE	M										M	M	M	M	M
Toluene													M	M	M
trans-1,2-DCE													M	M	M
TCE	M										M	M	M	M	M
Vinyl Chloride						M					M	M	M	M	M
<b>Inorganic Chemicals</b>															
Antimony						M									
Beryllium															
Cadmium						M					M		M	M	M
Chromium		M				M	M			M			M	M	M
Lead						M				M		M	M	M	M
Nickel						M				M	M		M	M	M
Sodium	H	H		H	H	H	H	H	H	H	H	H	H	H	H
Thallium										M					

M = contaminant exceeded the maximum contaminant level (MCL).

H = contaminant exceeded the state HAL; used where MCL does not exist.

**Table 3**  
**Preliminary Remediation Goals for Groundwater**  
**Boarhead Farms RI/FS**

Chemical	Preliminary Remediation Goal (mg/L)	Standard*
<b>Inorganic Chemicals</b>		
Antimony	0.006	MCL
Beryllium	0.004	MCL
Cadmium	0.005	MCL
Chromium	0.100	MCL
Copper	1.000	HAL
Lead	0.005	HAL
Nickel	0.100	MCL
Thallium	0.002	MCL
<b>Pesticides</b>		
Aldrin	2.00E-06	HAL
Bhc-Gamma(Lindane)	0.0002	MCL
Dieldrin	2.00E-06	HAL
<b>Semivolatile Organic Compounds</b>		
1,2-Dichlorobenzene	0.600	MCL
1,4-Dichlorobenzene	0.075	MCL
2,4-Dichlorophenol	0.020	HAL
bis(2-ethylhexyl)Phthalate	0.006	MCL
Naphthalene	0.020	HAL
<b>Volatile Organic Compounds</b>		
1,1,1-Trichloroethane	0.200	MCL
1,1,2-Trichloroethane	0.005	MCL
1,1-Dichloroethene	0.007	MCL
1,2-Dichloroethane	0.005	MCL
1,2-Dichloroethene (Total) <sup>b</sup>	0.07 <sup>c</sup>	MCL
1,2-Dichloropropane	0.005	MCL
Benzene	0.005	MCL
Carbon Tetrachloride	0.005	MCL
cis-1,2-dichloroethene <sup>b</sup>	0.070	MCL
Ethylbenzene	0.700	MCL
Methylene Chloride	0.005	MCL
Tetrachloroethene	0.005	MCL
Toluene	1.000	MCL
trans-1,2-dichloroethene <sup>b</sup>	0.100	MCL
Trichloroethene	0.005	MCL
Vinyl Chloride	0.002	MCL

\* MCL=Primary MCL from SDWA; HAL=PA Act 2 when primary MCL does not exist.

<sup>b</sup> COPC is listed as 1,2-DCE and xylenes only; various isomers were not differentiated.

<sup>c</sup> USEPA MCL value is for cis-1,2-DCE; a USEPA MCL for (total) 1,2-DCE is not available.

**Table 4**  
**Preliminary Remediation Goals for Soil**  
**Boarhead Farms RI/FS**

Chemical	Preliminary* Remediation Goal	Source
<b>Inorganic Chemicals (mg/kg)</b>		
Arsenic	316	BL
Barium	4,060	BL
Beryllium	9.18	BL
Cadmium	0.56	BL
Chromium	17,800	BL
Copper	7,290	BL
Lead	49.1	BL
Nickel	584	BL
<b>Pesticides (µg/kg)</b>		
Heptachlor	5.80	BL
<b>Semivolatile Organic Compounds (µg/kg)</b>		
Naphthalene	390	BL
1,2-Dichlorobenzene	1,410	LD
1,4-Dichlorobenzene	180	LD
<b>Volatile Organic Compounds (µg/kg)</b>		
1,1,1-Trichloroethane	149	BL
Ethylbenzene	62,200	BL
Tetrachloroethene	15.4	BL
Toluene	56,900	BL
Trichloroethene	397	BL
Xylenes (M & P)	1,300,000	BL
Xylenes (O)	1,300,000	BL
Xylenes (Total)	1,300,000	BL
1,1,2-Trichloroethane	0.58	LD
1,1-Dichloroethene	0.92	LD
1,2-Dichloroethane	0.14	LD
1,2-Dichloroethene (Total)	4.53	LD
1,2-Dichloropropane	0.52	LD
Benzene	0.66	LD
Carbon Tetrachloride	4.46	LD
Chlorobenzene	32.4	LD
Chloroform	8.93	LD
cis-1,2-dichloroethene	4.53	LD
Methylene Chloride	0.09	LD
trans-1,2-dichloroethene	12.0	LD
Vinyl Chloride	0.33	LD

Notes:

\*Established by site-specific PRG modeling using MULTIMED.

BL—K<sub>d</sub> values derived from site-specific batch leach tests.

LD—K<sub>d</sub> derived from literature.

(Literature-derived K<sub>d</sub> values were calculated using the organic carbon partitioning function obtained from the *Subsurface Contamination Reference Guide*, 1990, EPA/540/2-90/011), and site-specific measurements of total organic carbon.

PRG values rounded to three significant figures.

**Table 5**  
**Area-Specific Exceedances of MULTIMED-Based Preliminary Remediation Goals (PRGs)**  
**for Contaminants of Potential Concern in Subsurface Soil**  
**Boarhead Farms RI/FS**

	Area Where PRG is Exceeded							Detected Minimum	Detected Maximum	Detected Average
	1	2	5/6 South	5/6 North	7	Wetlands 3	Wetlands 12			
Inorganic Chemicals (mg/kg)										
Beryllium	X							0.12	1,200	10.9
Cadmium	X	X	X	X	X	X	X	0.25	423	21.2
Chromium, total								44.2	2,280	521.4
Lead	X	X	X	X				1.5	11,800	129.6
Semivolatile Organic Compounds (µg/kg)										
2-Methylnaphthelene								25	72,000	5,139
bis-2-(ethylhexyl)phthalate			X	X				42	100,000	5,474
Volatile Organic Compounds (µg/kg)										
1,1,1-Trichloroethane		X	X	X		X		1	94,000	6,282
Benzene		X		X				1.9	113	24
Tetrachloroethene	X	X	X	X		X		2	15,000	1,088
Toluene				X				1	870,000	30,898
Trichloroethene	X	X	X	X		X		1	2,200,000	35,615
Note: PRGs developed using the MULTIMED fate-and-transport modeling code.										

**Table 6**  
**Residential Wells with MCL Exceedances (data compiled through 12/95)**  
**Boarhead Farms RI/FS**

Well No.	Chemical	Concentration (µg/L)	Data Qualifier	MCL (µg/L)
RW-01	Antimony	22.4*	J	6
RW-01	bis(2-ethylhexyl)phthalate	12		6
RW-02	Pentachlorophenol	1	J	1
RW-05	Pentachlorophenol	2	J	1
RW-10	1,1,1-Trichloroethane	520		200
RW-10	Chromium	155		100
RW-10	Tetrachloroethene	5		5
RW-10	Trichloroethene	2800		5
RW-13	Thallium	2.4*	J	2
RW-14	Antimony	6.3*	KJ	6
RW-16	Lead	17.8*		15
RW-20	Antimony	13.2*	J	6
RW-21	Pentachlorophenol	2	J	1
RW-23	bis(2-ethylhexyl)phthalate	16		6
RW-23	Thallium	2.1*	JL	2
RW-25	bis(2-ethylhexyl)phthalate	6	J	6
RW-28	bis(2-ethylhexyl)phthalate	6		6
RW-31	bis(2-ethylhexyl)phthalate	14		6
RW-32	Chromium	648		100
RW-32	Nickel	311		100
RW-34	bis(2-ethylhexyl)phthalate	6		6
RW-34	Cadmium	6.4*	K	5
RW-35	bis(2-ethylhexyl)phthalate	16		6
RW-35	Cadmium	5.1*	K	5
RW-35	Chromium	446		100
RW-35	Nickel	218		100
RW-52	bis(2-ethylhexyl)phthalate	74		6
RW-54	bis(2-ethylhexyl)phthalate	72		6
RW-54	Thallium	2.2*	JL	2
RW-61	Antimony	14*	JL	6
RW-64	bis(2-ethylhexyl)phthalate	26		6
RW-64	Tetrachloroethene	12		5
RW-86	Thallium	2.7*	JL	2

Note:

Only primary MCLs were used.

\*MCLs for inorganics that only were exceeded during one sampling event.



**Table 7**

**SUMMARY OF THE COPCS IDENTIFIED THROUGH THE BOARHEAD FARMS HUMAN HEALTH RA**

Surface Soil	Shallow Groundwater			Pond Sediment	Pond Surface Water
Cadmium	Aluminum	Chloroform	2,4-Dinitrophenol	Arsenic	Chromium
Chromium	Arsenic	1,2-Dichlorobenzene	2-Methylnaphthalene	Beryllium	Manganese
Arsenic	Barium	1,4-Dichlorobenzene	4-Methylphenol	Chromium	
Beryllium	Beryllium	1,1-Dichloroethane	Naphthalene	Nickel	
Copper	Cadmium	1,2-Dichloroethane	Nitrobenzene		
Thallium	Chromium	1,1-Dichloroethene	2-Nitrophenol		
Zinc	Cobalt	1,2-Dichloroethene	1,2,4-Trichlorobenzene		
bis(2-Ethylhexyl)phthalate	Copper	1,2-Dichloropropane	2,4,6-Trichlorophenol		
n-Nitrosodipropylamine	Cyanide	Ethylbenzene	BHC-alpha		
	Lead	Methylene chloride	BHC-delta		
	Manganese	Methyl isobutyl ketone	Heptachlor		
	Nickel	1,1,2,2-Tetrachloroethane			
	Silver	Tetrachloroethene			
	Vanadium	Toluene			
	Thallium	1,1,1-Trichloroethane			
	Zinc	1,1,2-Trichloroethane			
	Benzene	Trichloroethene			
	Bromodichloromethane	Vinyl chloride			
	2-Butanone	Xylenes			
	Carbon tetrachloride	bis(2-Chloroethyl)ether			
	Chlorobenzene	2,4-Dichlorophenol			

Table 8

## TOXICITY VALUES USED IN THE HUMAN HEALTH RISK ASSESSMENT

Box 1a, d Farms

Chemical Name	Subchronic Oral RfD (mg/kg-day)	Source	Subchronic Inhal RfD (mg/kg-day)	Source	Chronic Oral RfD (mg/kg-day)	Source	Chronic Inhal RfD (mg/kg-day)	Source	Weight-of-Evidence Class	Source	Oral SF (mg/kg-day) <sup>-1</sup>	Source	Inhal SF (mg/kg-day) <sup>-1</sup>	Source
Acenaphthene	8.00E-01	H			8.00E-02	I								
Acetone	1.00E+00	H			1.00E-01	I								
Aidin	3.00E-05	H			3.00E-05	I			D	I				
Aluminum					1.00E+00	E			B2	I	1.70E+01	I	1.72E+01	I
Antimony	4.00E-04	H			4.00E-04	I								
Arsenic	3.00E-04	H			3.00E-04	I			C	O3				
Barium	7.00E-02	H	1.43E-03	H	7.00E-02	I	1.43E-04	H	D	O1	1.50E+00	I	5.1E+01	I
Benzene			1.7 x 10 <sup>-3</sup>	E					A	I	2.90E-02	I	2.91E-02	I
Benz(a)anthracene									B2	I	7.30E+00	I		
benz(b)fluoranthene									B2	I	7.30E-01	U		
benz(a,h)fluoranthene									C	I				
benz(k)fluoranthene									B2	I				
Benzic acid	4.00E-06	H			4.00E-06	I			C	I	7.30E-02	U		
Beryllium	5.00E-03	H			5.00E-03	I			B2	I	4.30E+00	I	8.40E+00	I
BHC alpha-									B2	I	6.30E+00	I	6.30E+00	I
BHC beta-									C	I	1.80E+00	I	1.80E+00	I
BHC gamma-	3.00E-03	H			3.00E-04	I			D	I				
Bis(2-chloroethyl)ether									B2, C	H	1.30E+00	H		
Bis(2-ethylhexyl)sebacate	2.00E-02	H			2.00E-02	I			B2	I	1.10E+00	I	1.1E+00	I
Bromochloromethane	2.00E-02	H			2.00E-02	I			B2	I	1.40E-02	I		
2-Butanone	5.00E-01	H	2.80E-01	H	8.00E-01	I	2.80E-01	I	B2	I	6.20E-02	I3		
Butylbenzyl phenylase n-	2.00E+00	H			2.00E-01	I			D	I				
Cadmium (carcinogenicity)									C	I				
Cadmium (flour)					1.00E-03	I			B1	I			6.30E+00	I
Cadmium (water)					5.00E-04	I			B1	I				
Carbon disulfide	1.00E-01	H	2.80E-03	H	1.00E-01	I	2.80E-03	H	B2	I	1.30E+00	I	1.30E+00	I
Carbon tetrachloride	7.00E-03	H			7.00E-04	I	5.71E-04	E	B2	I	1.30E-01	I	5.25E-02	I
Chlorobenzene	2.00E-01	H	5.71E-02	H	2.00E-02	I	5.71E-03	H	D	I				
Chloroethane	6.00E-06	H			6.00E-06	I								
Chloroethane			2.80E-03	H			2.80E-03	I						
Chloroform	1.00E-02	H			1.00E-02	I			B2	I	6.10E-03	I	6.05E-02	I
Chloromethane					3.80E-03	O2			C	H	1.30E-02	H	6.30E-03	H
4-Chloro-3-methylphenol	5.00E-01	H			5.00E-02	I			C	I				
2-Chlorophenol	5.00E-02	H			5.00E-03	I								
Chromium (hexavalent)	2.00E-02	H			5.00E-03	I			A	I			4.20E-01	I
Chromium (trivalent)	1.00E-01	H			1.00E-01	I			D	O1				
Chrysene									B2	I	7.30E-03	U		
Cobalt					8.00E-02	E								
Copper	3.70E-02	H			3.70E-02	H			D	I				
Cyanoide	2.00E-02	H			2.00E-02	I			D	I				
4,4'-DDD									B2	I	2.40E-01	I		
4,4'-DDE									B2	I	3.40E-01	I		
4,4'-DDT	5.00E-04	H			5.00E-04	I			B2	I	3.40E-01	I	3.40E-01	I
Debenz(a,h)anthracene									B2	I	7.30E+00	U		
D-n-butylphenolate	1.00E+00	H			1.00E-01	I			D	I				
1,2-Dichlorobenzene			5.71E-01	H	9.00E-02	I	5.71E-02	H	D	I				
1,3-Dichlorobenzene					8.90E-02	O1			D	I				
1,4-Dichlorobenzene			7.14E-01	H	1.00E-01	O1	2.29E-01	I	B2	H	2.40E-02	H		
1,1-Dichloroethane	1.00E+00	H	1.43E-03	H	1.00E-01	H	1.43E-01	H	C	I				
1,2-Dichloroethane									B2	I	9.10E-02	I	9.10E-02	I
1,1-Dichloroethane	9.00E-03	H			9.00E-03	I			C	I	8.00E-01	I	1.75E-01	I
1,2-Dichloroethane, (mixed)	9.00E-03	H			9.00E-03	H								
1,2-Dichloroethane, cis	1.00E-01	H			1.00E-02	H			D	I				
1,2-Dichloroethane, trans	2.00E-01	H			2.00E-02	I			O	O1				
2,4-Dichlorophenol	3.00E-03	H			3.00E-03	I								
1,2-Dichloropropane			3.71E-03	H			1.14E-03	I	B2	H	6.80E-02	H		
Dieldrin	5.00E-06	H			5.00E-06	I			B2	I	1.80E+01	I	1.61E+01	I
Dibenzofuran	8.00E-06	H			8.00E-01	I			D	I				
2,4-Dimethylphenol	2.00E-01	H			2.00E-02	I								
Dimethylphenol	1.00E+01	H			1.00E+01	H			D	I				
2,4-Dimethylphenol	2.00E-03	H			2.00E-03	I								
D-n-octyl-phthalate	2.00E-02	H			2.00E-02	H								
Endosulfan	8.00E-03	H			8.00E-03	I								
Enflur	3.00E-04	H			3.00E-04	I			D	I				
Ethylbenzene	1.00E+00	H	2.80E-01	H	1.00E-01	I	2.80E-01	H	D	I				
Fluoranthene	4.00E-01	H			4.00E-02	I			D	I				
Heptachlor	5.00E-04	H			5.00E-04	I			B2	I	4.50E+00	I	4.55E+00	I
Heptachlor epoxide	1.30E-06	H			1.30E-06	I			B2	I	9.10E+00	I	9.10E+00	I
2-Hexanone														
Indanal 1,2,3-cis-oxirane									B2	I	7.30E-01	U	6.10E-01	E
Iron														
Isosorbene	2.00E+00	H			2.00E-01	I			C	I	9.50E-04	I2		
Lead									B2	I				
Manganese (feed)	1.40E-01	H	1.14E-04	H	1.40E-01	I	1.43E-06	I	D	I				
Manganese (water)	5.00E-03	H	1.14E-04	H	5.00E-03	I	1.43E-06	I	D	I				
Mercury	3.00E-04	H	8.57E-03	H	3.00E-04	H	8.57E-06	H	D	I				
Methoxychlor	5.00E-03	H			5.00E-03	I			D	I				
Methylene chloride	8.00E-02	H	8.57E-01	H	8.00E-02	I	8.57E-01	H	B2	I	7.50E-03	I	1.65E-03	I
Methyl isobutyl ketone	5.00E-01	H	2.29E-01	H	5.00E-02	H	2.29E-02	H						
Methylisothiazole					4.00E-03	P1			D	I				

**Table 9**  
**Human Health Risks at the Boarhead Farms Site**

Group of Individuals	Cancer Risk	Hazard Index
Onsite Residents Consuming Groundwater from Onsite Residential Well	1.3E-03	52
Onsite Residents Consuming the most Contaminated Groundwater Onsite	3.5E-01	17,000
Onsite Residents on Public Water Supply	4.1E-05	0.24
Offsite Residents Consuming Groundwater Downgradient from Site	5.0E-04	7.6
Onsite Workers Consuming the most Contaminated Groundwater Onsite	3.3E-02	1800
Onsite Workers on Public Water Supply	4.3E-06	0.00056
Recreational Site Users - Wooded Upland Areas	8.4E-09	0.0083
Recreational Site Users - Wetlands	1.4E-06	2.0
Recreational Site Users - Ponds	3.5E-06	3.14
Recreational Site Users - Pond Fish Consumption	NA	0.059
Recreational Offsite Users - Culvert and Creek	1.3E-06	0.032
Recreational Offsite Users - Culvert and Creek Fish Consumption	5.8E-05	2.3

NCP determines unacceptable risks exist when greater than:  
Cancer Risk: 1.0E-04    Hazard Index: 1.0

## TABLE 10 - SUMMARY OF ALTERNATIVES

### Alternative 1

No Action

### Alternative 2

Continued Maintenance and Monitoring of the Existing Groundwater Interceptor Trench, Treatment facility, and residential Well GAC Filters; Institutional Controls

### Alternative 3

Soil Excavation, Multilayer Cap; Excavation and Offsite Disposal of Buried Drums; Groundwater Extraction, Metals Precipitation, and Air Stripping; Institutional Controls and Monitoring; and Residential Water Treatment

### Alternative 4

Soil Excavation and Stabilization/Solidification; Excavation and Offsite Disposal of Buried Drums; Groundwater Extraction, Metals Precipitation, and Air Stripping; Institutional Controls and Monitoring; and Residential Water Treatment

### Alternative 5

Excavation of Soil and Placement in Onsite Landfill; Excavation and Offsite Disposal of Buried Drums; Groundwater Extraction, Metals Precipitation, and Air Stripping; Institutional Controls and Monitoring; and Residential Water Treatment

### Alternative 6

Soil Aeration and Treatment of VOC Hot Spots; Excavation and Offsite Disposal of Buried Drums; Groundwater Extraction, Metals Precipitation, and Air Stripping; Institutional Controls and Monitoring; and Residential Water Treatment

**PART III**

**RESPONSIVENESS SUMMARY FOR THE PROPOSED REMEDIAL ACTION PLAN**

**AT THE**

**BOARHEAD FARMS SUPERFUND SITE**

**BRIDGETON TOWNSHIP, PA**

**Public Comment Period: January 5, 1998 - April 5 , 1998**



**RESPONSIVENESS SUMMARY  
BOARHEAD FARMS SITE  
BRIDGETON TOWNSHIP, BUCKS COUNTY, PENNSYLVANIA**

This community relations responsiveness summary is divided into the following sections:

**Overview:** This section discusses EPA's preferred alternative for remedial action.

**Background:** This section provides a brief history of community interest and concerns raised during remedial planning at the Boarhead Farms Site.

**Part I:** This section provides a summary of issues and concerns raised by the local community at the public meeting on January 14, 1998. "Local community" includes local homeowners, businesses, the municipality, and potentially responsible parties (PRPs).

**Part II:** This section provides a summary of commentors' issues received via electronic mail or written letters throughout the comment period.

**OVERVIEW**

On January 5, 1998, EPA published its preferred alternative for the Boarhead Farms Site, located in Bridgeton Township, Bucks County, Pennsylvania and announced the public comment period. EPA screened six possible alternatives to remediate groundwater and soil contamination, giving consideration to nine key evaluation criteria found in the NCP:

- Threshold criteria, including
  - Overall protection of human health and the environment
  - Compliance with Federal and state environmental laws
- Balancing criteria, including
  - Long-term effectiveness
  - Short-term effectiveness
  - Reduction of mobility, toxicity, or volume
  - Ability to implement
  - Cost, and
- Modifying criteria, including
  - State acceptance, and
  - Community acceptance

The preferred alternative, Alternative 6, includes the following measures:

- **Soil Aeration and Treatment of VOC Hot Spots:** Mechanical aeration of soil hot spot areas to remove high levels of VOCs (primarily TCE and benzene) in a temporary onsite treatment building equipped with carbon filters
- **Excavation and Offsite Disposal of Buried Drums:** Excavation and offsite disposal of buried drums to reduce the potential for continued migration of contaminants to the soil and groundwater as well as to reduce exposure risk
- **Groundwater Extraction, Metals Precipitation, and Air Stripping:** Continued extraction and treatment of VOCs in groundwater via the existing interception trench and air stripping treatment system and addition of a metals precipitation unit to remove inorganics to reduce contaminants in the groundwater to below Maximum Contaminant Levels (MCLs)
- **Installation of Additional Monitoring Wells:** Installation of additional (specific number to be determined during remedial design) monitoring wells to monitor the effectiveness of the remedial action. These wells will be placed in areas along the perimeter of the Site to permit monitoring of migration, if any, of contaminated groundwater
- **Institutional Controls and Monitoring:** Implementation of institutional controls to protect the integrity of the remedial action components and the previously installed soil cover to ensure continued protectiveness of the remedy.
- **Residential Water Treatment:** Continued maintenance of the granular activated carbon (GAC) filters that were installed on affected residential water wells in the surrounding area to prevent exposure to contaminated groundwater from the Site
- **Phytoremediation:** Performance of treatability studies in the main former disposal areas of the Site to determine whether phytoremediation is a viable treatment technique to aid in the removal of VOC and metals contamination in the groundwater.

## **BACKGROUND**

To obtain public input on the Proposed Remedial Action Plan (Proposed Plan or PRAP), EPA held a public comment period from January 5, 1998, to April 5, 1998. In addition, EPA held a public meeting on January 14, 1998, to explain the preferred alternative and to answer questions. Local residents and officials, news media representatives, representatives from EPA, and representatives from companies interested in Site activities and cleanup decisions attended the meeting.



EPA notified the public of the January 14, 1998, public meeting and announced the public comment period in a display ad placed in the January 5 and 9, 1998, editions of *The Intelligencer Record* and *The Morning Call*, and the January 8, 1998 edition of the *Delaware Valley News*. After the January 14 public meeting, EPA granted a request to extend the public comment period one month to March 6, 1998. EPA announced the extension in the January 29, 1998 editions of *The Intelligencer Record*, *The Morning Call*, and the *Delaware Valley News*. At the close of the March 6, 1998 extension, an additional request was made for another 30-day extension. EPA granted the request and the comment period, lasting a total of 90 days, closed on April 5, 1998.

In addition, EPA placed copies of the Proposed Plan in the Site information repository at the Bucks County Library Center. The repository contains the Administrative Record supporting selection of the Remedial Action including the Remedial Investigation, the Baseline Risk Assessment, the Ecological Risk Assessment, the Feasibility Study, the PRAP, and other relevant documents upon which EPA relied in selecting the Site remedy.

EPA also prepared a fact sheet and distributed it to individuals in attendance at the public meeting. The fact sheet included a summary of the Proposed Plan.

#### **Part I: Summary of Issues and Concerns Raised at the Public Meeting**

This section provides a summary of issues and concerns raised by the local community at the public meeting held on January 14, 1998. The comments can be grouped into six categories:

- A. Remedial Alternative Preferences
- B. Current Site Conditions
- C. Human Health Concerns
- D. Funding Issues
- E. Schedule
- F. Public Participation Process

The questions, comments, and responses are summarized below.

#### **A. Remedial Alternative Preferences**

1. A resident recommended that Alternative 5 be implemented at the Site since it includes removal of all contaminated soil, not just the soil in the highly contaminated "hot spot" areas.

*EPA Response: Alternative 5 proposes the creation of an onsite landfill. Landfills are often implemented at sites to prevent migration of hazardous substances offsite. EPA gave a great deal of consideration to Alternative 5 as a proposed remedy for this Site. However, Alternative 5 would not remove all contamination from the Site, but rather would place all contaminated soils in a central location, the onsite landfill (see the*

*Comparative Evaluation of Alternatives, Section IX of the ROD). In addition, an onsite landfill does not seem to be favorable to residents in the surrounding areas since it is expected that there would be some migration of contamination down from the landfill and along the surficial aquifer. Therefore the landfill alternative would not provide any additional benefit over the proposed remedy. The proposed remedy would remove from the Site the most contaminated soils, thus eliminating the possibility of any exposure to such contaminants by human and environmental receptors.*

2. A resident recommended the selection of Alternative 4 since it appears to address all areas of contamination.

*EPA Response: Alternative 4 proposes soil excavation and onsite solidification. As discussed in Section IX of the ROD (Comparative Evaluation of Alternatives), stabilization is the most expensive alternative proposed and does not present any environmental advantage over the selected alternative. Stabilization technology works well with certain types of wastes, particularly heavy metals. Recent literature on the effectiveness of stabilization on VOC contaminated soils shows that this approach is not always effective and the VOCs continue to leach from the stabilized areas. Therefore, while stabilization has been shown to be protective with respect to metals contaminated soils, EPA believes that this alternative may not be as protective of the community with respect to the VOC contamination. EPA believes that Alternative 6 will accomplish levels of protection which will be acceptable. It is important to note that when soils are solidified/stabilized, the contaminants remain onsite in a central location.*

3. Several residents expressed concern about the contaminated soil remaining on the Site after implementation of Alternative 6. They feel that there is a potential for rain water to infiltrate the soil and move contamination from the soil to the groundwater below.

*EPA Response: Offsite disposal was one of the first remedial processes considered. EPA agrees that the acidic rainfall in the area will infiltrate the soil and move contamination out; in fact, that process is an integral part of the remedy. The existing interceptor trench will collect all groundwater flowing from upgradient areas (where the contaminated soils are located) and direct these flows to the onsite treatment system. With the addition of a metals precipitation unit, all VOCs and metals of concern will be removed through this groundwater treatment system.*

4. A Bridgeton Township official asked how Alternative 6 would address groundwater contamination, particularly trichloroethylene (TCE), detected in upgradient wells along Deer Lane.

*EPA Response: Deer Lane is upgradient from the Site. The contaminants detected in the upgradient wells along Deer Lane are believed to be nonsite related since those contaminants were not found at the Boarhead Site. Since the wetlands are situated*

*between the Site and these well locations, and the wetlands act as a natural filtration system for VOCs, the contaminants in the upgradient wells will not impact the Site.*

5. A Bridgeton Township official expressed concern over EPA's decision not to implement the U.S. Department of Interior Fish and Wildlife Service's recommendations, dated January 26, 1996, for Site cleanup.

*EPA Response: U.S. Department of Interior Fish and Wildlife Service and EPA reached a joint recommendation based on a follow-up study (included in the Administrative Record) which followed from the recommendations presented in the January 26, 1996 letter. According to subsequent documents all contained in the Administrative Record, the recommendations of January 26, 1996 were changed and all risk and ecological issues have been addressed.*

6. A member of the Bridgeton Township Planning Commission asked how Alternative 6 will address groundwater contamination in the aquifer beneath the Site.

*EPA Response: Alternative 6 calls for continued use of the existing groundwater extraction and treatment system, with an upgrade to include metals precipitation. The groundwater extraction system captures groundwater in the shallow and intermediate aquifers. The shallow groundwater system is composed of the upper 40-50 feet of weathered and moderately fractured rock, and most of the groundwater flow occurs in this system. The majority of groundwater in the shallow system is captured by the extraction trench or is captured by the extraction wells. The shallow groundwater system grades into the intermediate groundwater system. The intermediate zone extends to approximately 500 feet below the ground surface, and has only minor amounts of fractures and associated groundwater. No fractures were identified below 100 feet. The intermediate groundwater system is considered an aquatard. Four hundred feet of unfractured diabase rock separates site groundwater from the deep groundwater system. The deep groundwater system is composed of fractured Triassic age sandstone and shale. Most residential wells in the area get their water from the deep groundwater system. EPA does not believe that the deep aquifer has been affected by contaminants from the Site.*

7. A member of the Bridgeton Planning Commission expressed concern that Alternative 6 does not address the source of the metals contamination.

*EPA Response: EPA conducted a large scale sampling of various residences in the area of the Site during the remedial investigation. Analyses of these sampling results showed elevated levels of various substances including some metals. Analytical results such as these are relatively common and are often encountered in "clean" areas as well as in areas near Superfund sites. Precipitation at the Site will wash the residual soil contamination (both metals and VOCs) into the shallow groundwater. The addition of*

metals treatment to the existing groundwater treatment plant will result in these metals being treated and removed through the interceptor trench system. Both EPA and PADEP have reviewed this data and feel that the elevated metals levels found in the otherwise uncontaminated areas around the Site are likely from the diabase rock formation which underlies this area.

8. A resident asked how long institutional controls would be in effect under Alternative 6 and what agency enforces them.

*EPA Response: Institutional controls will remain in effect as long as it is determined they are needed to protect the integrity of the remediation systems at the Site or until the Site no longer poses a risk or potential risk to the community. Enforcement of institutional controls is complex and depends on the manner in which such controls are implemented. Details regarding the form of institutional controls will be developed during implementation of the selected remedy. Both the Commonwealth and local authorities may impose additional controls and would be responsible for enforcing them.*

9. A resident recommended that EPA install an interceptor trench north of the Site to stop groundwater flow in a northerly direction since the contaminated groundwater may endanger the residents in that area.

*EPA Response: Installing an interceptor trench north of the Site would destroy the wooded wetlands in that area. It is EPA's belief that the current ecosystem in the wetlands is both containing and removing the high levels of TCE contamination in that area. If the wetlands were to be destroyed in order to construct an additional interceptor trench, much of the natural remediation that has been taking place would be reversed. EPA believes that, at best, an extended interceptor trench would be no more effective than the existing ecosystem. Construction of an additional interceptor trench would be detrimental to the wetland area and may also pose additional risks to people residing in this area since the existing ecosystem would be diminished.*

10. One resident expressed concern that there is no surface water monitoring of the streams and ponds located at or near the Site. Monitoring would help determine if the underlying groundwater is contaminating these surface water bodies.

*EPA Response: EPA has performed extensive monitoring of the surface streams and ponds both on the Site and in the adjacent community. Analyses of these data have satisfied EPA that the underlying groundwater is not contaminating these surface water bodies. These concentrations were incorporated into the Site-specific human health risk assessment. None of the low level contaminants found in the surface water exceeded the values for the Site-specific human health assessment.*

11. One resident asked whether the selected remedy can be adjusted to reflect conditions over its period of operation.

*EPA Response: Should EPA determine, at any time, that the selected remedy is not serving to protect the surrounding community (i.e., human health or the environment), the remedy will be reviewed and modified accordingly. In addition, EPA will review the selected remedy and issue a remedy review report at least every 5 years, anticipated to extend for 30 years, after the remedy is in place.*

**B. Current Site Conditions**

1. One resident asked how many drums are still buried at the Site.

*EPA Response: Based on the remedial investigation, EPA is certain that drums remain buried onsite; however, the exact number of drums cannot be determined at this time. Following the removal actions that took place in 1992 and 1993, EPA conducted a magnetometer survey of the Site and found approximately 20 additional anomalies. Anomalies can represent a variety of metal objects so EPA is not certain that all anomalies consist of drums. The anomaly locations will be further investigated during implementation of the remedy and any drums identified will be disposed of offsite.*

2. A Bridgeton Township official asked how EPA determined that all known radioactive wastes have been removed from the Site.

*EPA Response: During the removal actions in 1992 and 1993, EPA identified drums containing radioactive waste with labels from General Machine Corporation. General Machine was notified and proceeded, at that time, to remove all radioactive wastes that were detected from the Site. Subsequent surveys conducted by EPA have not found evidence of any other radioactive wastes at this Site.*

3. A resident asked for a description of the intermediate groundwater system and whether the existing interceptor trench collects contaminated groundwater from this system.

*EPA Response: The intermediate groundwater system is defined as being within the deep-dyabase bedrock, below 40 feet. The intermediate groundwater flow is through a network of very minor and limited fractures existing in the upper portion of this formation (approximately 10 -40 below ground surface). Although there is indication that groundwater may be capable of flowing from the shallow system to the fractures of the intermediate system, the fractures are limited in extent and hence the depth to which groundwater may flow is limited. In addition, hydraulic interconnection between the two systems is more likely at the edges of the dyabase sheet which extends well past the boundaries of the Site and the surrounding residences. EPA has installed extraction wells (EC wells) in areas where the groundwater does not flow into the interception*

trench. Some of these EC wells are directly in the intermediate groundwater system and collect groundwater from the fractures described above. The groundwater collected in the EC wells is pumped to the treatment system, treated and discharged.

4. A resident asked whether contamination was detected in the intermediate groundwater system.

*EPA Response: Low levels of contaminants were detected in a few of the intermediate groundwater wells. Water collected in these wells is pumped to the treatment system for treatment and discharge. The quantity of groundwater in this system is extremely small.*

5. Several residents expressed concern about the potential that contamination in the intermediate groundwater system will eventually reach residential wells at the Site.

*EPA Response: The intermediate groundwater system acts primarily as an aquatard (restricting flow movement). Very little, if any, groundwater passes through it. Even if groundwater flow in the intermediate system did increase, there would be negligible chance for the Site contamination to impact residential wells by this pathway.*

6. A Bridgeton Township official asked how the interceptor trench collects contaminants detected in groundwater downgradient of the Site.

*EPA Response: The extraction wells and interceptor trench capture contaminated groundwater downgradient from the contamination located onsite but do not treat groundwater located downgradient from the trench location. The wetland areas downgradient from the interceptor trench are only minimally contaminated (with the exception of the TCE hot spot area) and the contamination is being addressed through natural remediation. In addition, the selected remedy includes periodic resampling of the monitoring wells downgradient of the Site boundary. If contaminants are found at elevated levels, steps will be taken to ensure that any such contaminants are removed before they reach the surrounding community.*

7. A resident asked how long the existing interceptor trench has been operational.

*EPA Response: The existing groundwater interceptor trench has been collecting water flowing from the Site since October 1997.*

8. A resident asked whether the levels of contamination in the groundwater collected in the interceptor trench have decreased since its inception.

*EPA Response: Since EPA has been collecting data from this interceptor trench for a relatively short period of time, it is difficult to give an accurate answer to this question. Data collected to date indicate that the levels of contamination in the interceptor trench*

have remained relatively constant since the start up in October 1997. The efficiency for removal of VOCs through the treatment system is in excess of 99%.

9. A resident asked whether the levels of contaminants detected in the monitoring wells at the Site have decreased since the removal of drums and contaminated material through prior removal actions.

*EPA Response: There are a number of monitoring wells in and around the Site which have shown little or no contamination. Some of these wells were installed to provide background information; others as sentinel/monitoring wells, to provide early warning should contamination begin to migrate towards nearby residences. EPA's data from those monitoring wells where contamination was initially detected show that, overall, the amount of contamination detected in the groundwater has decreased since EPA's drum removal operation.*

10. A resident asked whether the tanker truck that was buried under the big pond in the 1970's was located and removed from the Site.

*EPA Response: EPA has conducted extensive "magnetic anomaly" surveys of the entire property and, to-date, has excavated, and removed in excess of 2,500 drums. No buried tanker trucks have been found. In addition, the large pond where the truck was thought to be buried was drained as part of the removal action, and a number of drums were also removed from the underlying soil. No evidence of any buried tanker truck(s) was found. Part of the selected remedy includes further excavations of the Site where magnetic anomalies have been observed.*

11. A resident asked for a quantification of groundwater that migrates offsite.

*EPA Response: Although EPA has not calculated the volume of groundwater that migrates from the Site, based on Site hydrogeology and groundwater pathways EPA is certain that all onsite groundwater migrates offsite. This occurs at different rates depending on the aquifer medium. The fastest flow occurs within the sand unit lying on top of the bedrock. Flow within this unit may be as high as 14 feet per day. Flows within the fractured bedrock are much slower and are generally much less than a foot per day. The highest concentrations of contaminated groundwater are captured by the groundwater extraction system. Lower concentrations of contaminated groundwater are remediated by natural mechanisms within the wetland area.*

12. A resident asked about the potential for groundwater contamination to migrate offsite if there has been no historical reports of offsite migration.

*EPA Response: EPA has studied the area around the Site, including the groundwater flow patterns, and determined that there is potential for contamination located on the Site*

to migrate offsite. Contamination has been measured in the groundwater onsite and in low levels leaving the Boarhead property. Currently, the existing interceptor trench and groundwater treatment system (constructed as part of a separate removal action) collect a large amount of the onsite groundwater and treat it onsite, thus reducing the potential for migration of groundwater offsite. However, EPA has installed a series of monitoring wells along the perimeter of the Site as a precaution and can determine if contaminated groundwater begins to move offsite.

### **C. Human Health Concerns**

1. A resident asked about the distinction between risks to onsite residents and risks to residents living near the Site.

*EPA Response: As both the Proposed Plan and this ROD present in table form, the risks to onsite residents are much greater than the risks to neighboring residents. Risk, as presented in EPA documents, relates only to the real or potential exposure of persons to substances present onsite. High levels of contamination were found in the onsite residential well as well as in soils near the farmhouse. The levels found in the residential wells neighboring the Boarhead property were minimal to none.*

2. A resident asked for an explanation of EPA's terminology of "maximum cancer risk" (e.g.,  $1.3E-03$  for onsite residents consuming groundwater from onsite residential wells).

*EPA Response: The value  $1.3E-03$  means that, based on statistical data for onsite residents drinking water from the most contaminated onsite well, there would be an expected increase above the normal rate in the indices of cancer in this group of an additional 1.3 cancers per 1,000 persons. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) established acceptable levels of carcinogenic risk for Superfund sites ranging from one excess cancer case per 10,000 persons exposed to one excess cancer case per one million persons exposed. This translates to a risk range of between one in 10,000 and one in one million additional cancer cases. Expressed as scientific notation, this risk range is between  $1.0E-04$  and  $1.0E-06$ . Remedial action is warranted at a site when the calculated cancer risk level exceeds  $1.0E-04$ . However, since EPA's cleanup goal is generally to reduce the risk of  $1.0E-06$  or less, EPA often takes action where the risk is within the range between  $1.0E-04$  and  $1.0E-06$ .*

*The cancer risk of  $1.3E-03$  (1 additional cancer occurrence in a population of 1300) for onsite residents consuming groundwater from the Site is above EPA's determined maximum cancer risk. EPA's goal in cleaning up sites is to reduce the risk posed by site contaminants to less than one in a million or  $1E-06$ .*



3. A resident asked for a comparison of Site risks to normal risks of living elsewhere.

*EPA Response: The Baseline Human Health Risk Assessment (BLRA) conducted by EPA provides all risk information regarding both onsite and offsite residents. For the purposes of EPA's Site assessment, risk is defined as the potential increase in the number of cancer incidents due to Site contamination. Since the cancer risks associated with living elsewhere are impacted by numerous environmental conditions and personal decisions, EPA cannot make a determination regarding the difference in cancer risk associated with living in the vicinity of Boarhead Farms and living elsewhere. However, as is described in both the Feasibility Study and the Proposed Plan, EPA has determined that risks are much greater to onsite residents drinking and using onsite well water than to those living in the vicinity of the Site.*

4. A resident asked whether the cancer risk to residents living near the Site will reduce to zero once the preferred alternative is implemented.

*EPA Response: Cancer risk arises from both environmental conditions and personal decisions (e.g., intentional exposure to tobacco products). The selected remedial action obviously will not address risks presented through personal choice and which are unrelated to Site contamination. EPA's goal is to reduce the risk of additional cancer incidents from contaminants at the Site to less than one in a million.*

5. A resident expressed concern about protection of human health that Alternative 6 would provide once it was implemented.

*EPA Response: Soil aeration and treatment of TCE and benzene soil hot spots called for in the selected remedy will reduce the risk of exposure to high levels of contamination in the hot spot areas. In addition, soil aeration will eliminate the possibility of TCE and benzene leaching into the groundwater from the hot spot soils.*

*Excavation and offsite disposal of the remaining buried drums and associated soils will reduce to acceptable levels the risk of the contaminants associated with the drums leaching into the groundwater or further contaminating the surrounding soils. Filling in these excavated areas will reduce the potential of future exposure to contaminated soils through ingestion and direct contact.*

*Groundwater extraction, metals precipitation, and air stripping through upgrading the existing groundwater treatment facility will reduce the potential of contaminated groundwater moving offsite. The upgraded system will remove VOC and metals contamination from all groundwater flowing into the interceptor trench and extraction wells. This will reduce the risks of exposure through inhalation, ingestion and dermal contact to offsite residents.*

*Institutional controls and monitoring will reduce the possibility of further exposure to contaminated soils, further consumption of contaminated groundwater, and further ingestion of contaminated fish from the culverts and creeks. EPA believes that the full implementation of the selected remedy will reduce the site related risks to the community to less than one in a million or 1E-06.*

**D. Funding Issues**

1. A resident was concerned about EPA having adequate funding to perform Alternative 6.

*EPA Response: EPA will first seek to have the Potentially Responsible Parties (PRPs) complete this remedial action. Shortly after the issuance of this Record of Decision (ROD), EPA will initiate a process for negotiations to commence with the PRPs to conduct the cleanup activities. Should the negotiations fail to produce an agreement, EPA will consider other enforcement and/or funding options which include, among others, ordering the PRPs to implement the remedy or using federal funds to implement the remedy.*

**E. Schedule**

1. A resident asked how long it would take to implement Alternative 6.

*EPA Response: EPA expects that the design of the remedy will begin in 1999 and the construction may begin in 2000. EPA estimates that it will take between 18 and 24 months to complete the construction of the remedial components.*

**F. Public Participation Process**

1. A property owner who resides elsewhere commented that EPA did not notify him of the public meeting. He stated that, in the past, he had been notified of meetings via direct mailing.

*EPA Response: In this case, the property owner had been on a mailing list that had been deleted through unforeseen circumstances. EPA produced a new mailing list, identifying addresses within a certain radius of the Site. The property owner in question has been added to the new mailing list.*

2. A resident requested that the public comment period be extended to provide adequate time for review of relevant Site documents.

*EPA Response: EPA extended the comment period to a total of 90 days. The first extension of 30 days was granted in January 1998 and announced at the public meeting*

on January 14, 1998. The second extension was granted after receiving requests from the Bridgeton Township Supervisors and was announced on March 6, 1998. The comment period officially closed on April 5, 1998. Since EPA believes that there has been an extensive public comment period, EPA does not intend to reopen the comment period at this time.

**Part II: Summary of Comments and Questions Received in Writing During the Public Comment Period**

This section provides a summary of commentors' issues received via electronic mail or written letters throughout the comment period. The following specific comments are addressed:

- A. Comments of Brenda S. Schneider
- B. Comments of Debi Slatkin
- C. Comments of the Bridgeton Township Planning Commission
- D. Comments of Jonathan C. Roller
- E. Comments of Upper Black Eddy Historic Preservation Society
- F. Comments of Wegard D. Holby
- G. Comments of Larry Schultz
- H. Comments of Bridgeton Township Supervisors
- I. Comments of Lawler, Matusky & Skelly Engineers, LLP (LMS) on behalf of the Boarhead Farms PRP Group

**A. Comments of Brenda S. Schneider**

In a one-page letter dated January 23, 1998, Brenda S. Schneider, a resident of Upper Black Eddy, submitted comments regarding the Proposed Plan and the remediation process for the Boarhead Farms Site.

1. Concern was expressed that the remedial action at the Site is an opportunity to do away with all presently contaminated and/or uncontaminated wells in the affected vicinity of the Site, forcing residents to use city water and raise taxes.

*EPA Response: The selected remedial action is intended to protect human health and the environment from the contamination at the Boarhead Farms Site. EPA has determined that residents living in the vicinity of the Site currently are not at risk from the contaminants present at the Site; therefore, the alternative of placing surrounding residents on public water was not considered in the Feasibility Study nor the Proposed Plan and is not a part of this Record of Decision.*

2. Who makes the final decision on which "Alternative Plan" is chosen and why isn't the Proposed Plan more specific.

*EPA Response: EPA makes the final decision on which alternative will be chosen for implementation at the Site. EPA seeks concurrence from the Pennsylvania Department of Environmental Protection (PADEP) and requests comments from the public to ensure that all concerns on the proposed alternative are addressed. Comments from the public, as well as from other agencies, play a large role in the decision process.*

*The Proposed Plan serves to provide a summary of past actions and current conditions at the Site as well as to explain the process used by EPA to select a preferred alternative from among several alternatives developed in the Feasibility Study. The Proposed Plan contains sufficient detail to enable the public to engage in meaningful participation as required by the Superfund statute and the NCP. Details not provided in the Proposed Plan may be gleaned from the Administrative Record file compiled for the Site. Neither the Proposed Plan nor the Record of Decision are intended to contain the level of detail necessary to actually implement the selected remedy. This information is developed during the Remedial Design Phase of the cleanup. The level of detail developed for each of the alternatives (and reported in the Proposed Plan and Record of Decision) is, however, sufficient to enable the Agency to apply the nine decision criteria established in the NCP in the selection process.*

3. Which "nearby residents" have home well treatment systems, and how can those who do not have a home well treatment system obtain one?

*EPA Response: During the Remedial Investigation EPA sampled residential wells in the vicinity of the Site that had the potential of being impacted by the Site contamination. Upon review of the results, in 1997 EPA provided filters to those residences which may have been impacted from the Site. EPA does not have any evidence indicating that there currently are additional homes with wells impacted by the Site. There are a number of commercially available treatment systems for individual purchase for those who are concerned about the quality of their well water.*

**B. Comments of Debi Slatkin**

In an electronic mail message dated March 3, 1998, Debi Slatkin, a resident of Upper Black Eddy, submitted comments to EPA regarding the preferred alternative for the Boarhead Farms Superfund Site.

1. Once the remedy is in place the Site should be used as a public nature preserve or similar use. The land should not be taken out of use and therefore should not be capped (Alternative 3) nor an onsite landfill created (Alternative 5).

*EPA Response: EPA does not intend to cap or construct an onsite landfill. At present the Site is privately owned, and the owners can use the property as they see fit. Use of the property does have to be in accordance with existing deed and zoning restrictions and*

cannot interfere with the ongoing Site remediation. The selected remedy does include institutional controls which will restrict certain activities in certain areas of the Site in order to protect the integrity of the remedy.

2. The toxic metals present in the soils should be addressed directly, before they have leached into the groundwater. These soils will pose a risk to human health and the environment unless the metals are directly removed from the soil.

*EPA Response: While EPA agrees that the best way to deal with metals contamination is some sort of direct intervention, such an approach is not possible at this Site. The metals contaminants were disposed of in separate areas at different times, and it is not technically or economically feasible to excavate and treat each separate area of metals contamination in the soils. Treatment of different metals requires separate processes, and the presence of other contaminants could significantly inhibit the removal process and would elevate costs considerably. The diabase rock formation on which most of the Site is located prevents most of the metals from leaching into the groundwater aquifer used by the area residences for drinking water. EPA will treat and remove the hazardous metals present in the surficial aquifer and in the surface soils by the addition of a metals precipitation unit in the current groundwater collection and treatment system.*

3. Additional extraction wells should be placed downgradient from all hot spot areas. In addition, more residential well testing should take place.

*EPA Response: EPA will consider the placement of additional wells based on the results of the monitoring to determine the effectiveness of the existing groundwater collection trench. EPA is concerned that additional extraction wells may either dewater the wetland areas, or if of sufficient depth, pull down the water table and leave residences without drinking water. Monitoring wells were placed downgradient from the areas and are monitored on a regular basis. Once the hot spot areas are remediated, the high levels of benzene and TCE in the soils will be removed and will not appreciably leach into the groundwater. In addition, the TCE hot spot is located in a wetland area and EPA believes that the TCE in the groundwater is being remediated through natural remediation within the existing wetland plants. This is evidenced by the lack of TCE in the downgradient monitoring wells located along Lonely Cottage Road.*

*EPA has sampled residential wells in the past. Such monitoring will continue as part of the selected remedy until the determination is made that no further residential well monitoring is necessary.*

C. **Comments of the Bridgeton Township Planning Commission**

In a two-page letter dated March 3, 1998, Carmen Hopf, Chair of the Bridgeton Township Planning Commission, submitted comments to EPA regarding the Boarhead Farms Proposed Plan.

1. The proposed remedial alternative (Alternative 6) does not adequately protect human health and the environment. It is an incomplete solution and will leave a legacy of contamination in our township after EPA leaves the Site.

*EPA Response: EPA believes that Alternative 6 does protect human health and the environment. As discussed in both the Proposed Plan and the Feasibility Study, Alternative 6 is protective and represents the best balance of the nine evaluation criteria set forth in the NCP, 40 C.F.R. Section 300.430(e)(9). The proposed alternative reduces current and potential risks to acceptable levels established in the NCP.*

2. EPA is only proposing to precipitate the metals from the recovered groundwater and not address the source of the contaminants. The toxic metals are present in surface soils at elevated concentrations and pose a health risk.

*EPA Response: See Response B.2 of Part II of this Responsiveness Summary. After the drum removal actions of 1992 and 1993, a layer of clean fill was placed over the excavation areas and eliminated the exposure risk to surface soil. Institutional controls will be implemented to restrict excavation and other activities that might adversely impact the effectiveness of this cover.*

3. Under the description for Alternative 6 it seems that soils that contain heavy metals will be returned to excavated areas after being treated only for VOCs. We do not wish to see the area capped (Alternative 3) or an onsite landfill created (Alternative 5). Treatments such as surfactant flushing or phytoremediation can lower metals concentrations in soils and should be evaluated.

*EPA Response: EPA will place clean fill in the excavated hot spot areas. EPA does not plan to cap the area nor to construct an onsite landfill. EPA has investigated surfactant flushing and believes that the Site is too large for surfactant flushing to be of benefit. In addition, surfactant flushing is most beneficial in groundwater with high levels of non-aqueous phase liquids (NAPLs), which do not pose a problem at the Boarhead Farms Site (see the memo from Jim Harper, Site RPM to File: "Boarhead Soils Remediation" (undated) included in the Administrative Record for the Boarhead Farms Site). EPA believes that the onsite wetlands are currently performing natural remediation in the TCE hot spot area. In addition, the selected remedial action includes treatability studies to determine if phytoremediation will aid in uptake of contaminants from the main disposal area.*

4. We would also like to see extraction wells in, or downgradient from, all the identified hot spots. We wish to keep the wetlands as protected as possible - extraction wells, rather than an additional trench, will have much less of an environmental impact.

*EPA Response: See Response B.3 of Part II of the Responsiveness Summary regarding the additional extraction wells. EPA does not plan to install an additional interception trench along the perimeter of the wetlands since such installation would destroy a natural habitat that is performing natural remediation.*

5. EPA should continue to test and monitor residential wells for toxicity to assure that contamination is not spreading. We request that EPA provide the Township with updated maps showing the residential and monitoring well contamination at each test interval.

*EPA Response: Testing of residential wells will continue as part of the selected remedy until EPA determines that such testing is no longer necessary. EPA has provided the Township with the Remedial Investigation Report which contains extensive maps delineating the areas of contamination. As progress towards the Site remediation continues, EPA will provide the community with additional findings and information.*

**D. Comments of Jonathan C. Roller**

In a one-page letter dated March 10, 1998, Jonathon C. Roller, a resident of Upper Black Eddy, submitted comments to EPA regarding the alternatives listed in the Proposed Plan for the Boarhead Farms Site.

1. Alternative 6 does not protect the citizens surrounding the Site, nor does it solve the long term goals EPA should have foremost in its mind.

*EPA Response: See Response C.1 in Part II of this Responsiveness Summary.*

2. The contamination in the soils should be addressed directly through processes such as surfactant flushing or phytoremediation.

*EPA Response: See Response C.3 in Part II of this Responsiveness Summary.*

3. The idea of an onsite landfill (Alternative 3) is not in the best interests of anyone, and does not show that EPA has thoroughly examined the effects such an idea would have on the surroundings.

*EPA Response: EPA does not intend to construct an onsite landfill as part of the remedial action. However, onsite landfills have been used at other Superfund sites and can be, under appropriate circumstances, an acceptable component of the remedial*

*action. The Feasibility Study in the Administrative Record describes EPA's reasoning for consideration of the onsite landfill as well as a comparison with other options.*

**E. Comments of the Upper Black Eddy Historic Preservation Society (UBEHPS)**

In a two-page letter dated March 25, 1998 Roger W. Keller, AIA and President of the UBEHPS, submitted comments to EPA regarding EPA's Boarhead Farms Proposed Plan.

1. The plan does not include removal of all soil containing toxic metals as well as the specific source of these contaminants. Even after the metals precipitation process is implemented, the metals in the surface soil will continue to pose a risk to the community. We do not wish to see the area capped, or an onsite landfill created and want the EPA to return the Site to a pristine condition by removing all contaminated soils.

*EPA Response: See Responses B.2, C.3, and D.3 in Part III of this Responsiveness Summary.*

2. We are gravely concerned at the suggestion of containment of toxic materials in our soils and water - both our drinking supply and the water that is fed into streams, the Delaware Canal, and Delaware River. Bridgeton Township relies solely on groundwater as a potable water supply, no amount of remaining toxicity is acceptable. We must be assured that the Site is clean both now and well into the future if such containment plans prove inadequate or the monitoring has ended.

*EPA Response: EPA has determined that the selected remedy is protective in that all unacceptable risks will be eliminated and believes that Alternative 6 presents the best balance of the nine criteria set forth in the NCP. Removal of all hazardous substances is neither necessary nor cost-effective. As part of this remedy, selected home wells and Site monitoring wells will continue to be monitored to ensure that the selected remedy meets the Performance Standards.*

3. The EPA must continue to test and monitor residential wells in Bridgeton Township for toxicity. We trust that EPA will do this for properties in areas adjacent to the Site and the 22 contaminated wells; we want to see testing of outlying areas for assurance over time that the toxicity is not spreading.

*EPA Response: See Response C.5 in Part III of this Responsiveness Summary. In addition, outlying monitoring wells will continue to be sampled as part of the selected remedy to ensure that contamination is not migrating offsite.*

4. We request that EPA provide Bridgeton Township with an updated map showing residential and monitoring well contamination at each test interval. We would also like to see maps that plot the interpolated concentration and spread of contaminants.



*EPA Response: See Response C.5 in Part III of this Responsiveness Summary.*

**F. Comments of Wegard D. Holby**

In a one-page letter dated March 25, 1998 Wegard D. Holby, a resident of Upper Black Eddy, submitted comments on the alternatives presented in the Boarhead Farms Proposed Plan.

1. The proposed plan to "remediate" the Boarhead Farms Site in Bridgeton Township by simply capping the area or creating an onsite landfill is a concern. In a growing residential community that relies exclusively on well water the plan seems shortsighted and may pose significant risks to our community.

*EPA Response: While capping (Alternative 3) is often implemented by EPA at sites with multiple component contaminants, such as those present at this Site, our evaluation using the decisionmaking criteria set forth in the NCP indicates that there are more effective methods for addressing the contaminants present. Therefore, EPA did not select capping (Alternative 3) nor an onsite landfill (Alternative 5) as the preferred alternative for remediation. In addition, EPA is currently treating the groundwater through the onsite treatment plant and through carbon filtration on residential well systems. The selected alternative will provide further groundwater remediation to reduce risks presented by the Site to the residential water supply.*

**G. Comments of Larry Schultz**

In a two-page letter dated April 2, 1998 Larry Schultz, a resident of Upper Black Eddy, submitted comments to EPA regarding EPA's Boarhead Farms Proposed Plan.

1. EPA should be sure to remediate on the side of health and well being of the surrounding residents rather than concentrating on cost effectiveness.

*EPA Response: EPA selects a remedy using the nine criteria set forth in the NCP, 40 C.F.R. Section 300.430(e)(9). These criteria are biased toward the overall protection of human health and the environment. The data collected and remedy selected are carefully reviewed by EPA toxicologists and other Agencies (such as the Agency for Toxic Substances and Disease Registry) that specifically deal with community health issues. While the NCP directs EPA to consider cost among the five primary balancing criteria in the remedy selection process, the NCP is clear that a remedy must meet the threshold criteria of overall protection of human health and the environment and compliance with ARARs. For more information, see the "Comparative Evaluation of Alternatives" section of the Boarhead Farms Proposed Plan or the section of the same title in this Record of Decision.*

## H. Comments of Bridgeton Township Supervisors

In an eight-page letter dated April 3, 1998, Barbara H. Guth, Wayne A. Brown, and John F. Hoernle of the Bridgeton Township Supervisors submitted comments to EPA regarding the Boarhead Farms Proposed Plan.

1. Offsite migration of hazardous chemicals through the southeastern wooded wetlands and swamp is not significantly addressed in the preferred remedy.

*EPA Response: With the installation of the interceptor trench, contaminants are removed from the groundwater before they reach the southeastern wooded wetland areas. In addition, EPA believes that the wetland areas are performing natural remediation on the contaminants that were present previous to the installation of the trench. At the suggestion of the community EPA has agreed to include in the selected remedy the installation of additional monitoring wells in order to be sure that the community remains protected.*

2. The possibility of contamination migrating to the northeast of the Site is not addressed in the preferred alternative.

*EPA Response: The northeastern part of the Site consists of high quality wooded wetlands. Wetlands serve as natural remediation for VOCs and may also aid in containing a contaminant plume. A set of monitoring wells lies on the edge of the Site, between the wetlands and Lonely Cottage Road and would indicate if the contamination was moving in the northeastern direction. EPA has not found evidence to suggest that the TCE from the hot spot in the wetlands has migrated offsite. There is some analytical data which indicate that chromium and other metals are present in some nearby residential wells; however, additional data, including the analytical results from the monitoring wells located between these residences and the Site contamination, suggest that these metals concentrations are not Site-related.*

3. The possibility that contaminants have migrated into the underground aquifer (used for residential water supply) from other contaminated wells and areas was not addressed in the Proposed Plan.

*EPA Response: During the Remedial Investigation (a copy of which is contained in the Administrative Record), EPA performed an extensive study of the groundwater in the area surrounding the Boarhead Farms Site. The purpose of this study was twofold: 1) to determine the types and concentrations of hazardous substances present in the groundwater and 2) to identify all potential sources (including, but not limited to, the Boarhead Farms property) of contaminants which may be contributing to the conditions present in this area. As part of this study, EPA examined the results from both the residential wells as well as the data obtained from the monitoring wells installed by EPA.*

*As is common with many hazardous waste sites, EPA found contamination unrelated to the Boarhead Farms Site. In developing this remedy, EPA has determined that there are currently no other sources in the area which pose an environmental risk to this community. EPA is satisfied that all risks posed by this Site have been adequately evaluated in the studies included in the Administrative Record.*

**I. Comments of Lawler, Matusky & Skelly Engineers, LLP (LMS) on behalf of the Boarhead Farms PRP Group**

In a 25 page document dated April 3, 1998, LMS, on behalf of the Boarhead Farms PRP Group, submitted comments on the Proposed Plan for the Boarhead Farms Site.

1. The proposed addition of metals removal is not warranted by Site conditions. The treatment system already meets PADEP 1197 guidance for discharge swales. We recommend that EPA work directly with PADEP to develop precise effluent limits that protect the water quality criteria of receiving waters. The use of ion exchange units at the wells where the inorganics of concern are being found at elevated levels would more efficiently assure the reduction of metals in the discharge.

*EPA Response: Analyses of the groundwater collected by the existing collection trench indicates that there are elevated levels of metals which currently exceed maximum concentration limits (MCLs). EPA has not yet provided PADEP with all requisite information to determine NPDES limits and alternate values may be developed as a result of this design effort; however, based on the ecological studies performed by EPA and contained in the Administrative Record, the current discharge from the groundwater collection trench will require treatment for metals prior to discharge.*

2. Air emissions from the air stripper easily meet the PADEP air emission requirements and therefore do not require the addition of off-gas carbon treatment for VOCs.

*EPA Response: Since a full study of the air emissions from this unit has not yet been performed, EPA believes the addition of a vapor-phase carbon unit for off-gas treatment is necessary. Some initial crude measurements, using OVAs, indicate that vapor control measures will be required. Furthermore, under 25 Pa. Code Section 121.1, all of Bucks County, including the Site, is located within the Southeast Pennsylvania Air Basin, which is considered a non-attainment area for ozone. These high ozone levels require that organic vapor emissions be limited.*

3. The October 1997 Soil Aeration Analysis performed by EPA's technical support section indicates that VOC emissions will not exceed PADEP air emission criteria. Carbon treatment (with an approximate cost of \$1 million) therefore is far more than is necessary to protect human health and the environment from air emissions.

*EPA Response: It is premature to argue the merits of various forms of requisite emissions controls and limitations. The selected remedy requires that emissions from remedial actions comply with all federal and state ARARs. During the remedial design phase of the remedy this issue can be addressed and modifications made to the remedial action, if and as appropriate.*

4. With respect to offsite residential wells, the PADOH, in conjunction with the Agency for Toxic Substances and Disease Registry (ATSDR), concluded that there is no health hazard and found that ample protection is provided by natural geologic features and the remedial work that has already taken place. In light of the fact that 25 years have passed since the Boarhead Farms Site first received government scrutiny, these conclusions lead us to believe that carbon filters or ion exchange units on offsite residential wells are not needed. The traces of contamination that have been found in these wells have not been linked to the Site.

*EPA Response: Both EPA and the PADOH have determined that groundwater flow from the Site flows directly towards the residences on the eastern side of the property. It is true that contaminant levels have been low in the monitoring wells located between the residences and the Site contamination, but both Agencies are concerned that these residences remain protected. It is possible that the release of Site-related contaminants into the aquifer could occur. EPA has determined that the filter systems are necessary to reduce risks presented by such releases. EPA also agrees that some of the offsite contamination (e.g., chromium) are most likely not Site-related and are due to the natural background levels in the underlying diabase bedrock. EPA has taken this into account in the selected remedy, which does not call for specific action to address such sources.*

5. In light of the abundant data that has been collected in the last 25 years, the three proposed additional sentinel/monitoring wells are not needed to monitor the extent of natural attenuation. Data in the Administrative Record demonstrate that no unacceptable risk exists from exposure to surface soil; fencing is necessary only to protect treatment systems and is not required Site-wide. Instead, a deed restriction barring future residential use would better protect human health by preventing exposure to probable subsurface contamination through construction or excavation.

*EPA Response: The purpose of the sentinel/monitoring wells is more than just monitoring the extent of natural attenuation. The wells are needed to ensure continual protection and that the contamination is not moving toward the residences. The exact number of sentinel wells is still subject to design considerations and may decrease or increase based on field determinations. At a minimum, an additional sentinel well is needed at Lonely Cottage Road where the small stream crosses the road near the Bridgeton Sportmans Club. Institutional controls to protect the remedy components and the previously installed soil cover are part of the selected remedy.*

6. There is concern that EPA has significantly underestimated the costs of the remedial alternative in the Proposed Plan. Although the Plan recommends a practical and efficient "hot spot" removal of contaminated soil, the proposal neither quantifies the number of areas to be excavated nor clearly identifies criteria to define the extent of the excavations.

*EPA Response: EPA has reasonably quantified the hot spots based on extensive sampling of these areas. EPA has estimated the amount of soil to be excavated from the hot spots to be approximately 12,000 cubic yards (cy). However, since three removal actions have occurred and the groundwater treatment system has been in operation since October, 1997, it is likely that the levels of contamination in the hot spot areas have reduced through both EPA actions and natural remediation through the wetlands. Further delineation of the extent of the hot spot removal of contaminated soil will take place during the course of the remedial design. In addition, EPA believes that the associated costs developed for these remedial alternatives are sound and are not underestimated.*



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5